FEBRUARY, 1922 Number 6

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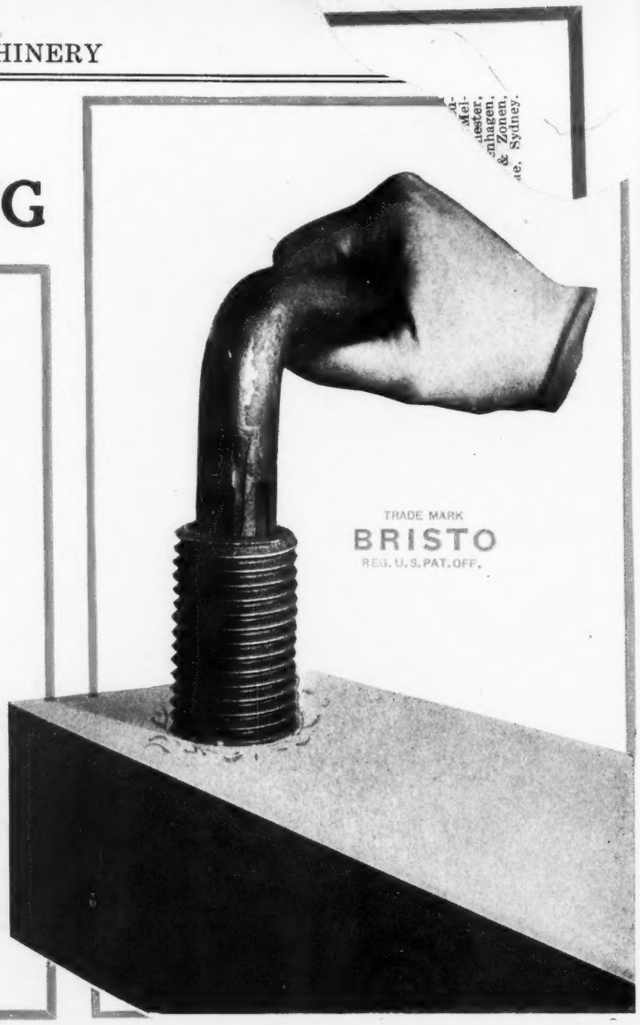

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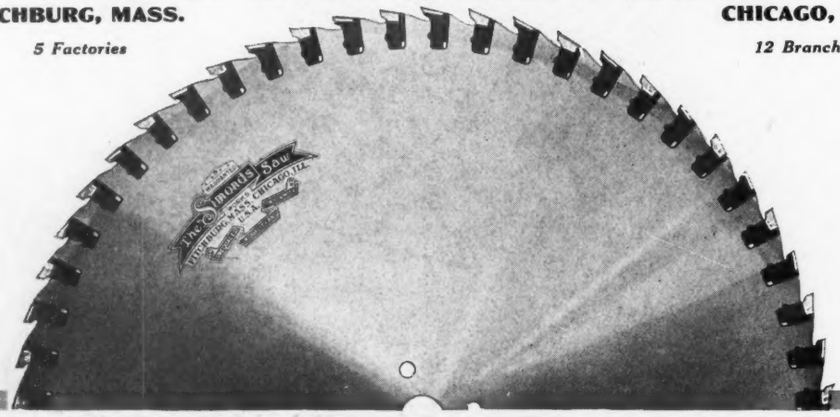


FEBRUARY MACHINERY 1922

Commercial Gear-cutting Practice

First Article of a Series Dealing with the Use of Different Types of Gear-cutting Machines for Cutting Various Classes of Gearing

This Installment Covers the Cutting of Spur Gears on Automatic Machines of the Formed-cutter Type

By FRANKLIN D. JONES

A COMPLETE history of all machine tools and mechanical processes used in machine shops would contain no part more fascinating than that dealing with the origin and development of gear-cutting machines. The necessity of utilizing positive means for transmitting rotary motions in machines accounts for the fact that the general subject of gearing has engaged the attention of engineers for generations, and since gearing of some type is in common use on almost every kind of mechanism, it is not surprising that gear-cutting is a subject of unparalleled interest among machine shop processes.

This article and others to follow will deal with the different methods and machines now used for cutting gears of various types and sizes, from small precision gears up to very large, heavy designs. In this general review of the subject, the object will be to show (1) how gears of different kinds are cut; (2) what types of machines are used under different conditions; (3) what factors affect production and quality; (4) commercial rates of production for cutting gears by different processes; and to give other important facts for the user or prospective user of gear-cutting machines. The development of the highly specialized gear-cutting machines now employed has required a vast amount of experimenting, and the designing and redesigning of many different types of machines and cutters to obtain equipment capable not only of cutting accurate gearing but also of working on a commercial basis.

The modern gear-cutting processes to be described will include the cutting of spur, straight-tooth, bevel, spiral bevel, helical (or spiral), double-helical or herringbone, and worm gearing.

General Classification of Gear-cutting Processes

The gear-cutting processes commonly utilized for producing different types of gears may be divided into three general classes. One includes the use of tools or cutters which form gear teeth by reproducing the shape of the cutter itself; in another class are the generating processes whereby the proper tooth curves are formed through relative motions of the tool and work, as when a straight-sided cutting tool generates the required tooth curves due to the rotary motion imparted to the gear blank. The third general classification includes the use of templets or master formers, which control the path followed by the cutting tool, and consequently the curvature of the gear tooth. This method is applied chiefly to the cutting of very large gears, and like the other processes referred to will be illustrated later by examples from practice.

The tool which cuts or forms the gear teeth may either revolve or have a reciprocating motion. When the shape of the cutter is directly reproduced on the gear, a revolving or disk type of cutter is generally used, the gear teeth being formed by milling operations. In some cases, a formed tool having a reciprocating motion may be employed, as, for example, when a gear is cut on a shaper or slotter because a regular gear-cutting machine is not at hand. Many machines of the generating type have revolving cutters, whereas other classes of generating machines operate with a planing or reciprocating motion. Machines of the templet or form-copying type are in the planer class. The forms of cutters used on different machines and the methods of applying these machines to various classes of gearing are to be illustrated by examples representing a wide range of practice.

This series of articles will form a complete treatise on the cutting of spur gears, straight-tooth bevel gears, spiral bevel gears, helical and herringbone gears, internal gears, worm-gears, and worms. There will be numerous examples from practice ranging from small instrument gears up to very large spur and bevel gears. Recent developments in gear-cutting machinery will be included, together with specific information covering operating principles, methods of setting up machines, time required for cutting gears of different types and sizes, and other essential points.

Different Methods of Cutting Spur Gears

The cutting of spur gears will be dealt with first, since this type is used much more than any other. Spur gearing, in common with other classes, may be cut by a number of different methods, each of which is satisfactory when applied under favorable conditions. These gear-cutting methods include (1) milling the teeth with cutters conforming to the shape of the spaces between the teeth; (2) milling the teeth with a cutter of the hob type, which represents a rack in the axial plane and is used in generating the tooth curves; (3) planing with a circular cutter which has teeth like a gear and serves to generate the tooth curves as the cutter and gear blank revolve

in unison; (4) planing with a tool that takes a series of cuts across the side of the tooth and is guided by a templet or former as it is gradually fed inward; (5) planing with a tool that conforms to a single rack tooth and generates the tooth curves as it moves laterally after each stroke, while the gear blank receives an indexing movement that causes each tooth to mesh properly with the traversing tool; (6) planing with a tool which is similar to a short section of a rack and is used in generating tooth curves as the gear blank rotates relative to the rack cutter; and (7) planing the teeth of the gear by the use of a formed tool which is of the same shape as the tooth spaces.

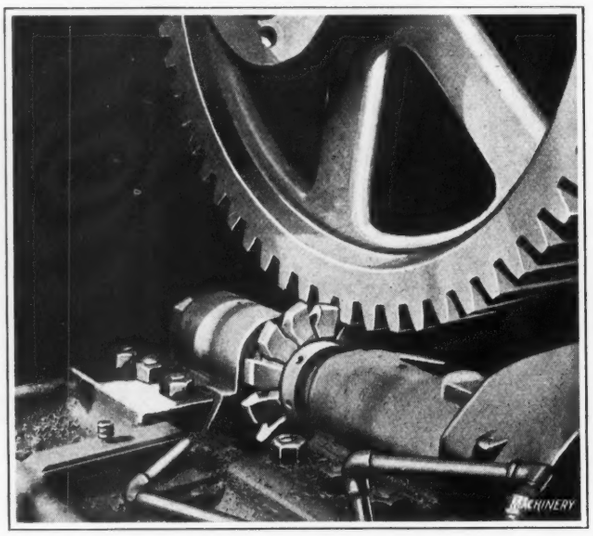


Fig. 1. Cutting a Spur Gear with a Formed Cutter

These various processes are utilized in manufacturing plants of different kinds, because the method of cutting gears, in common with other shop processes, depends upon such factors as the quantity of work to be done, its size, and the degree of accuracy necessary. For instance, the gear-cutting practice in a general repair shop would ordinarily differ from the methods used in the average plant manufacturing, say, machine tools; and still other variations are found in automobile plants, particularly where production is on a very large scale. The manufacturers of gear-cutting machines have developed types to meet these different conditions. For example, there are machines designed for general gear-cutting operations, and other highly specialized types intended solely for cutting large numbers of duplicate gears.

An example of specialization is found in the automotive field where machines of special design are used exclusively for roughing bevel gears preparatory to finishing in other machines. In this instance, it is essential to combine high production with accuracy, which is obtained by using the special machines for rapid roughing and other machines for accurately generating the tooth curves. While these very special types of gear-cutting machines are not found in many shops—considering the machine-building field as a whole—they illustrate what has been done by gear-cutting machine manufacturers to meet different commercial requirements. Just how various gear-cutting processes and types of machines are applied both in plants requiring high production as well as in shops where the variety of gear sizes is large in proportion to the number of gears cut, will be illustrated by many diversified examples of gear-cutting practice.

Cutting Spur Gears by the Disk or Formed-cutter Method

The disk or formed-cutter method is utilized in a great many shops, especially for cutting spur gears. This is a non-generating method, the shape of the gear tooth being a reproduction of the shape of the cutter. It has been applied successfully to a wide range of work, including very small precision gears as well as large heavy spur gears. A close-up view of a formed cutter at work is illustrated in Fig. 1. It will be seen from this illustration that this is merely a milling operation.

When gears of small or medium size are required in small quantities or odd sizes, formed cutters are often used in standard types of milling machines, particularly in repair and jobbing shops, but this and other articles to follow will deal only with machines designed expressly for gear-cutting.

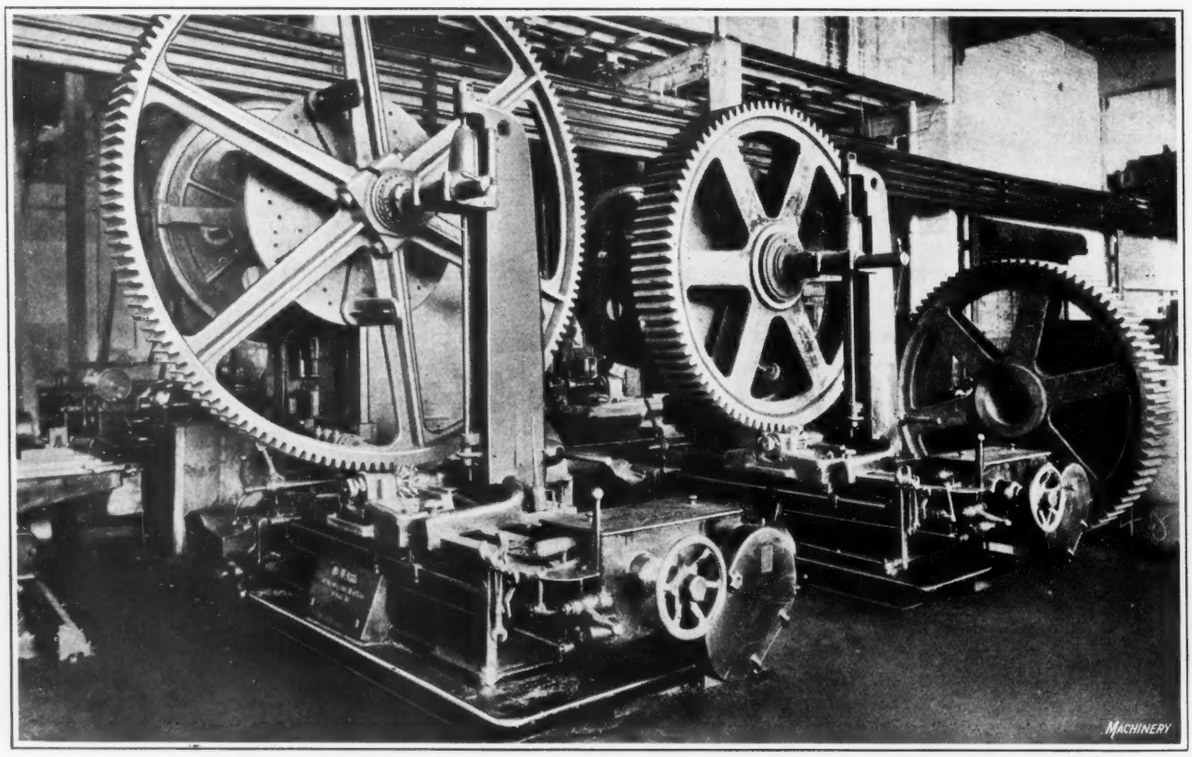


Fig. 2. Examples of Gear-cutting on Machines of the Formed-cutter Horizontal-feeding Type

The machines of the formed-cutter type are commonly known as automatic gear-cutting machines because, after the gear blank or blanks are in the cutting position and the machine is properly adjusted, all the gear teeth are cut automatically without further attention on the part of the operator. Certain other types of gear-cutting machines also operate automatically except for the insertion and removal of the work, although the term "automatic" is not used in designating them to the same extent as in the case of spur-gear machines.

The general characteristics of these automatic spur-gear machines include a main spindle for holding and driving the work-holding arbor; a cutter-slide arranged to move parallel with the axis of the work-spindle; a mechanism for feeding the cutter-slide at a suitable rate and returning it to the starting point; and a mechanism for indexing the gear blank after each tooth space is milled. The arrangement of different makes of these machines varies somewhat. For instance, the cutter-slide of some machines has a horizontal feeding movement along the main bed, as in the example shown in Fig. 2, and the work-spindle is carried by a slide having vertical adjustment along a column, to suit the gear diameter. The cutter-slides of other machines feed vertically along the face of the column, as in Fig. 4, and the work-spindle is held in a vertical position on a slide or table mounted on horizontal ways formed on the main bed. The details of indexing and feeding mechanisms as well as other parts also vary in design, as will be seen by a comparison of illustrations to follow; this series of articles, however, will deal chiefly with gear-cutting processes and the methods of *using* different types of machines rather than with their design, especially as the latter is related to constructional details.

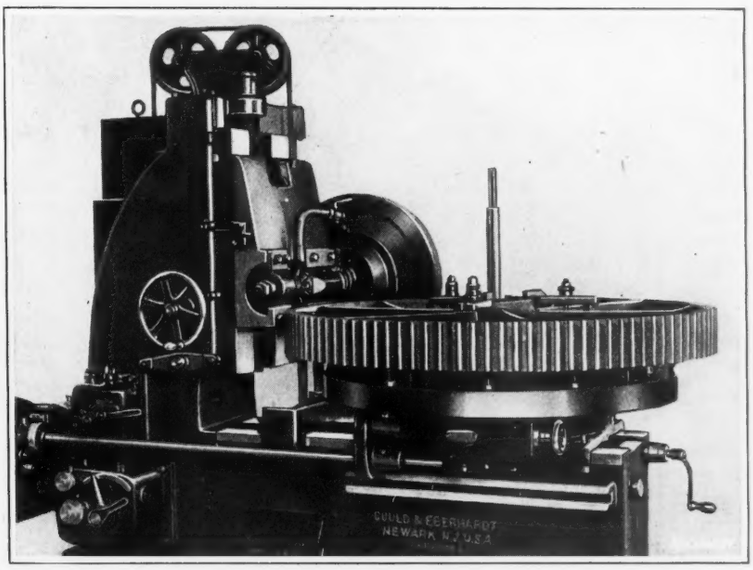


Fig. 4. Cutting a Cast-steel Spur Gear on a Machine of the Vertical-cutting Type

Centering Cutter Relative to Gear Blank

While the exact method of setting up or adjusting automatic gear-cutting machines varies somewhat for different makes, the general procedure will be reviewed briefly and later some of the more important features will be more fully described. After selecting a cutter of the right pitch and number, this cutter with its arbor is placed in the working position. The cutter-spindle bearing is then adjusted to locate the cutter central with the work-spindle so that the center line of each tooth space cut in the gear blank will be radial. This is usually done by means of a centering gage or indicator supplied with the machine. The type of gage used on Newark gear-cutting machines is illustrated in Fig. 3. It consists of a steel straightedge *A* having a vee formed in one end. This straightedge or gage, when in use, is placed on a horizontal surface in contact with the raised edge *B* which holds the gage in alignment. The gage-supporting surface is located on the cutter-slide. The cutter is set in the central position by simply adjusting the spindle laterally until one of the cutter teeth is in contact with both sides of the V-shaped notch when the gage is held firmly against the raised aligning edge *B* of the support.

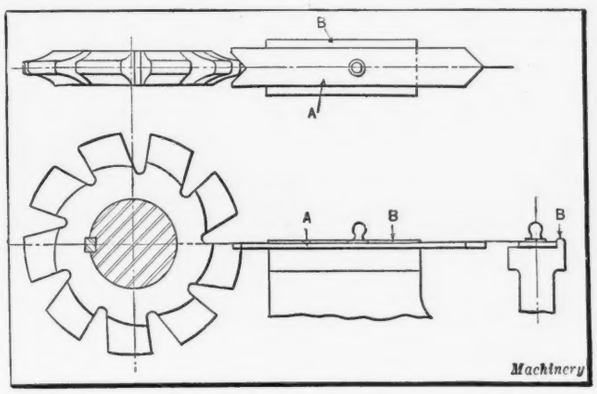


Fig. 3. One Type of Gage used to center Cutter Relative to Gear Blank

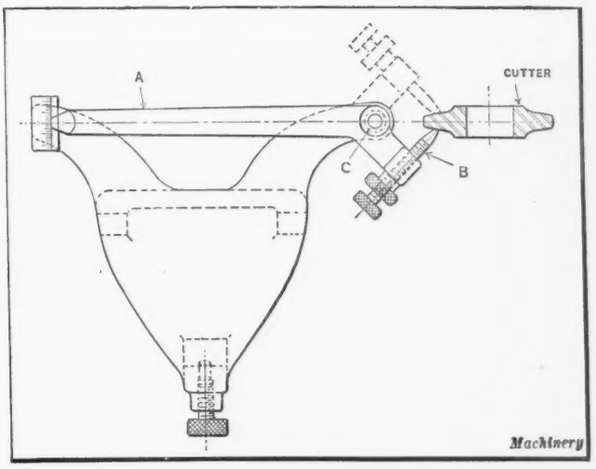


Fig. 5. Another Type of Cutter-centering Gage

The type of indicator used on Brown & Sharpe machines is illustrated in Fig. 5. This indicator is clamped to the ways of the bed in front of the cutter-slide. The cutter-spindle is adjusted until indicating lever *A* shows that it is in a central position. The point of screw *B* should come in contact with the cutter approximately at the pitch line. The position of the indicating lever is then reversed on pivot *C*, as indicated by the dotted lines. If the zero line on lever *A* is equidistant from the zero line on the gage, for the two positions of contact point *B*, this shows that the cutter is in a central position. If preferred, screw *B* may be so adjusted that the lever *A* stands at the zero position and both zero lines will coincide when the cutter is central.

While the indicator just described enables the cutter to be set accurately enough for ordinary purposes, the method of centering recommended when very accurate quiet-running gears are required is as follows: First turn a blank to the same size as the gears to be cut; then, after centering it as accurately as possible, take a single cut through this blank. Without changing the position of the cutter, remove the blank from the work-arbor and reverse its position. Next, with the blank free to turn on the arbor, feed the cutter into the slot previously milled and revolve it by pulling the

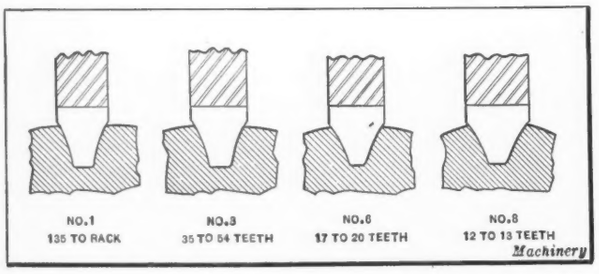


Fig. 6. Diagram showing Variations in Shapes of Gear-cutters of the Same Pitch but intended for Small, Medium, and Large Size Gears

belt so as to mark its position relative to the slot. If the second cut follows the outline of the first, the cutter is exactly central, but if the cutter removes some stock from the top of the space on one side and the bottom of the other, this indicates an inaccurate setting. When such an error is detected, the cutter should be adjusted away from that side of the tooth from which stock was removed at the deepest part of the cut. After this has been done, a second cut is taken in the blank, and the procedure described in the foregoing is repeated to check the adjustment again.

Other Adjustments when Setting up Machines

Another important point to consider when setting up a machine is the method of supporting the work. An arbor inserted in the main spindle is generally used, and frequently this arbor is additionally supported by an arm or outer bearing. It is good practice to test the accuracy of the arbor when setting up a machine. This may be done by placing a dial indicator in contact with it; the worm of the indexing mechanism is disengaged from the index-wheel to permit revolving the spindle and arbor by hand, and then the indicator shows whether the arbor is concentric with the machine spindle. The gear blank or in some cases two or more blanks are placed on the arbor, the number depending upon the width and general proportions of the blanks. The indexing mechanism is geared to agree with the number of teeth to be cut, the proper combination of gearing for a given number of teeth being shown by the chart accompanying the machine. The cutter speed and rate of feed are regulated by means of change-gears, according to the pitch of the gear to be cut, the kind of material, and the kind of steel used in making the cutter. Speed and feed plates attached to the machine show the speeds in revolutions per minute, and the feeds either in inches per minute or per revolution of the cutter. The slide supporting the gear blank is adjusted to mill teeth of the proper depth and thickness, usually by means of a graduated dial on the machine, reading to thousandths of an inch.

The usual practice is to finish each tooth space by one passage of the cutter, although two cuts are sometimes required. The rim rest, which is used whenever possible to take the thrust of the cut, is adjusted so as to support the gear blank without interfering with the indexing movement. Before bringing the indexing worm in mesh with the wheel, it is well to turn the spindle by hand to make sure that the rim rest does not bind tightly against the work.

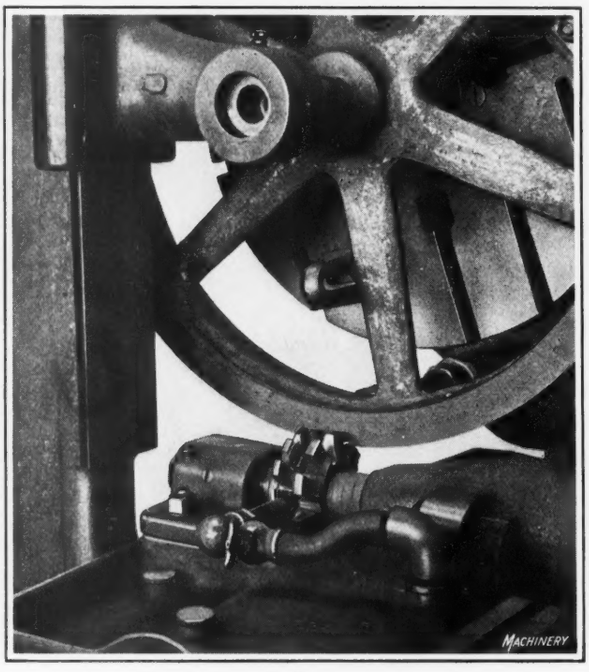


Fig. 7. Machine equipped with Two Cutters for taking Roughing and Finishing Cuts simultaneously

As any error in the adjusting of the indexing mechanism would be very serious, the indexing movement is sometimes tested before cutting the gear. One method is to nick the blank in one place and then index by hand to correspond to the number of teeth to be cut in order to see if the nick in the blank is in alignment with the cutter after the work has been indexed one revolution. Another method is to start two grooves or tooth spaces, cutting far enough into the blank to give the tooth its full form for a short distance. The chordal thickness at the pitch line is then measured by using a vernier gear-tooth caliper.

Before the machine is ready for use, the dogs that control the stroke of the cutter-slide must be adjusted to give the slide a movement sufficient to allow the cutter to pass through the blank and then return far enough to permit indexing. One dog is set so that the feeding movement of the slide is reversed after the center of the cutter passes the end of the work. The other dog is then set to stop the return movement when the cutter clears the blank, at a distance of, say, about ¼ inch, or enough to provide clearance for the indexing movement. This clearance should not be excessive, as this simply increases the idle time, thus decreasing the rate of production.

Selecting a Formed Cutter for Spur Gears

Formed cutters for cutting spur gears must not only be of the required diametral pitch, but they must also be selected with reference to the number of teeth in the gear to be cut. For example, a cutter for a gear having 28 teeth of 8 diametral pitch differs in shape from a cutter for a gear of the same pitch having, say, 60 teeth. The variations in the shapes of cutters Nos. 1, 3, 6, and 8 are illustrated by the diagrams in Fig. 6. The involute cutters commonly used are made in series of eight cutters for each diametral pitch. Cutter No. 1 is intended for gears ranging from 135 teeth to a rack; No. 2 from 55 to 134 teeth; No. 3 from 35 to 54 teeth; No. 4 from 26 to 34 teeth; No. 5 from 21 to 25 teeth; No. 6 from 17 to 20 teeth; No. 7 from 14 to 16 teeth; and No. 8

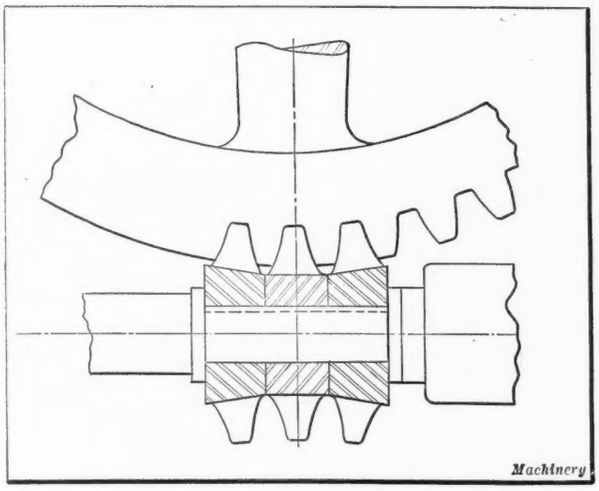


Fig. 8. Gang Cutter for finishing Two Teeth simultaneously

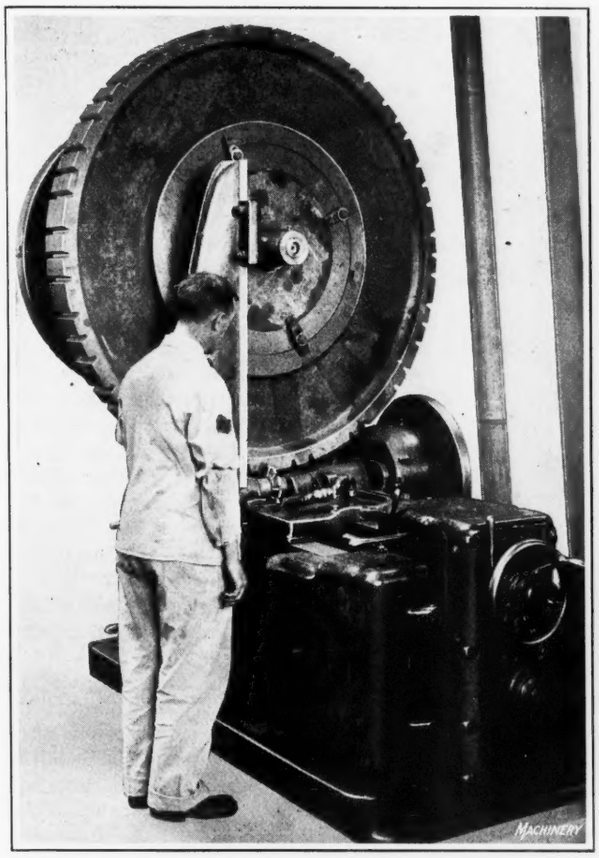


Fig. 9. Example illustrating Application of Intermittent Indexing

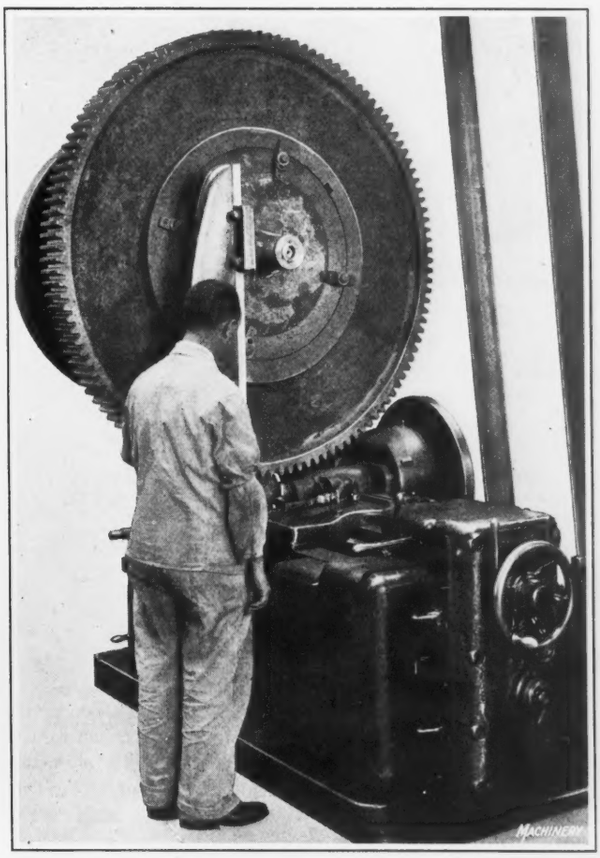


Fig. 10. Finishing the Gear roughed out as illustrated in Fig. 9

for 12 and 13 teeth. The shape of each cutter in this series is correct for a certain number of teeth only, but it can be used for other numbers within the limits given. For instance, a No. 6 cutter may be used for gears having from 17 to 20 teeth, but the tooth outline is correct only for 17 teeth or the lowest number in the range, which is also true of the other cutters listed. When this cutter is used for a gear having, say, 19 teeth, too much material is removed from the addenda of the teeth, although the gear meets ordinary requirements.

These cutters are so formed or relieved that the faces of the teeth may be ground for sharpening without changing the outline of the tooth curve. It is essential when grinding to keep the face of each tooth radial or in a plane intersecting the axis. All teeth must also be of the same height, so that the work of cutting will be distributed uniformly, instead of having one or two high teeth do all the work. Another important point is to keep the cutters sharp, because this increases production, decreases the power required for driving the machine, and produces a smoother and also a better wearing tooth surface on the gear.

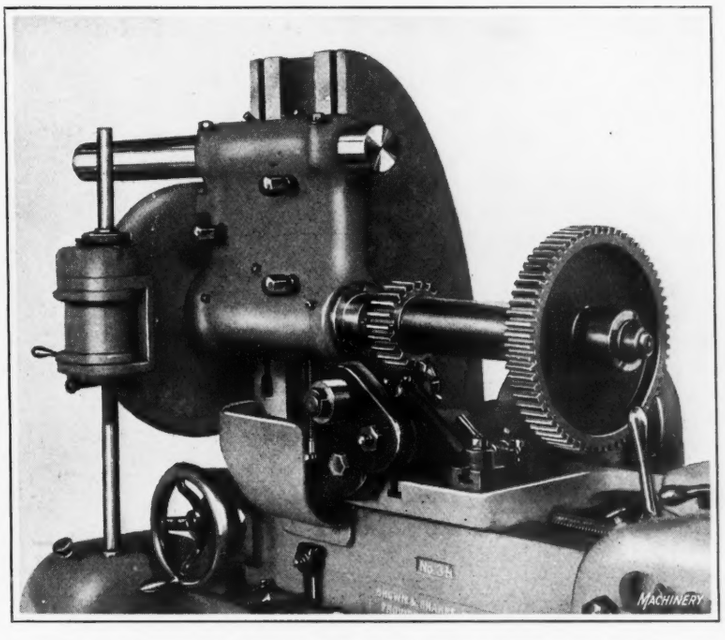


Fig. 11. Gear-cutting Machine equipped with Special Attachment for cutting Quill Gears

Intermediate Series of Cutters to Obtain Greater Refinement

When greater accuracy of tooth shape is desired to insure smoother or quieter operation, an intermediate series of cutters having half numbers is used. The half numbered cutters made by the Brown & Sharpe Mfg. Co., Providence, R. I., are for the following ranges of tooth numbers: Cutter No. 1½, 80 to 134 teeth; No. 2½, 42 to 54; No. 3½, 30 to 34; No. 4½, 23 to 25; 5½, 19 and 20; 6½, 15 and 16; and 7½, 13 teeth. There are seven cutters in this series, No. 8½ being omitted since this would be for a pinion with less than 12 teeth. What has been said about cutter selection applies particularly to spur gears. When bevel gears are cut by the milling process, as will be explained in one of the articles to follow, the method of determining what cutter number to use is different from the method employed in the case of spur gears.

Formed Cutters for Spur Gears with Stub Teeth

Involute gears having a 14½-degree pressure angle are generally considered standard, and are ordinarily cut by gear manufacturers unless otherwise specified, although the stub-tooth gear having a 20-degree pressure angle might be considered standard in the automobile field, as applied to transmis-

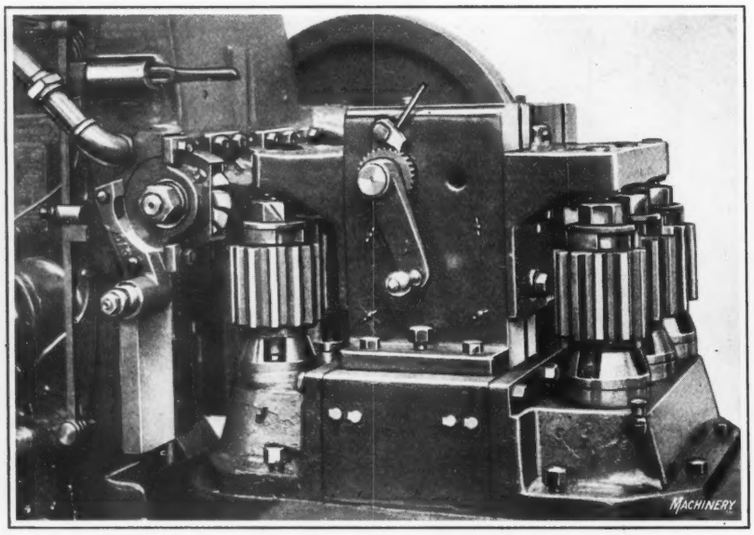


Fig. 12. Example of Gear-cutting on Machine of Multiple-cutter Revolving-turret Type

sions and for certain other applications requiring exceptionally strong gear teeth. Because of the increased pressure angle of a stub-tooth gear, the change in tooth outline is more pronounced for different numbers of teeth than with a 14½-degree pressure angle; hence, in order to secure the same degree of refinement, a larger number of cutters is required for each pitch. While the series of eight cutters referred to may be used for each pitch, a set of fifteen cutters is recommended by the Brown & Sharpe Mfg. Co. to obtain the accuracy ordinarily expected in gears of smaller pressure angle. This set of cutters includes the eight regular numbers plus the seven half numbers or intermediate shapes referred to. To obtain the best results, the cutter should be made special to suit the exact number of teeth required.

Number of Cuts Necessary for Gears of Different Pitches

As a general rule, each tooth space is finished by one passage of the cutter when the teeth are formed by milling, although two cuts are frequently taken, especially when cutting large pitches. The degree of accuracy and finish desired may also have a bearing upon the number of cuts necessary. Ordinarily, when the teeth of cast-iron gears are coarser than 2 diametral pitch, it is good practice to take roughing and finishing cuts. When the gears are made of steel or hard bronze, roughing and finishing cuts are preferable for 4 diametral pitch or coarser. While cast-iron gears up to 2½ diametral pitch can usually be finished satisfactorily with one passage of the cutter, it will be understood that the condition of both machine and cutter might change the conditions decidedly. When a second cut is taken for finishing, it is important to have the roughed-out tooth spaces central with the cutter to avoid removing unequal amounts of metal on the sides, since this tends to wear the cutting edges unevenly and produce inaccurate teeth. If roughing cuts are taken, the stocking cutter should be set to mill the teeth the full depth, the allowance for finishing being on the sides. Stocking cutters having ridges to break up the chips are commonly used.

Using Cutters in Gangs to Reduce Time for Cutting Gears

A gang of two or more cutters is sometimes mounted on an arbor, so that all the cutters operate simultaneously. One method is to place a stocking cutter in advance of the finishing cutter, as illustrated in Fig. 7, the finishing cutter being in the central position. This plan is also followed in cutting rack teeth, a common method being to place a stocking cutter and a finishing cutter side by side.

Another arrangement of gang cutters is illustrated in Fig. 8, which shows how two teeth may be finished at each indexing by using a gang of three cutters. It will be noted that the end cutters are of special shape, which is one disadvantage of this method. When accurate gears are required, the gang-cutter method is not advisable; when used, it is generally applied to cutting gears of small pitch, especially when required in large quantities. In general, the use of gang cutters is not recommended for the best classes of work. Ordinarily when the finishing cutter is preceded by a stocking cutter, the teeth are not milled as accurately as when these cutters are used separately; moreover, gang cutters for finishing two or more teeth simultaneously are inferior to the single-cutter method as regards accuracy.

Determining Cutter Speed and Rate of Feed for Cutter-slide

Actual tests are necessary to determine the most effective combinations of cutter speed and feed, because in addition to the pitch of the gear and the cutting qualities of the metal, speeds and feeds are decidedly affected by the kind of cutter used, its condition, especially in regard to sharpness, rigidity of both machine and work, the provision for cooling the cutter, and other variable factors. The following figures obtained from the Brown & Sharpe Mfg. Co. are given as a guide only, and other speeds and feeds should be substituted whenever actual tests show that they will give better results and higher production. When average conditions exist, high-speed steel cutter speeds may vary from 80 to 125 feet per minute for cast iron, and from 65 to 100 feet per minute for machine steel. When carbon steel cutters are used, the speeds for cast iron are ordinarily from 60 to 70 feet per minute, and for machine steel from 30 to 40 feet per minute.

RATES OF FEED, IN INCHES PER MINUTE, FOR CUTTER-SLIDE

Diametral Pitch	2	2½	3	4	5	6	7	8	10	12	16
Cast iron . .	3½	3½	4	4½	4½	5	6	6	7	8	9
Steel	1½	1½	2	2½	2½	3	4	4	4½	5	6

Machinery

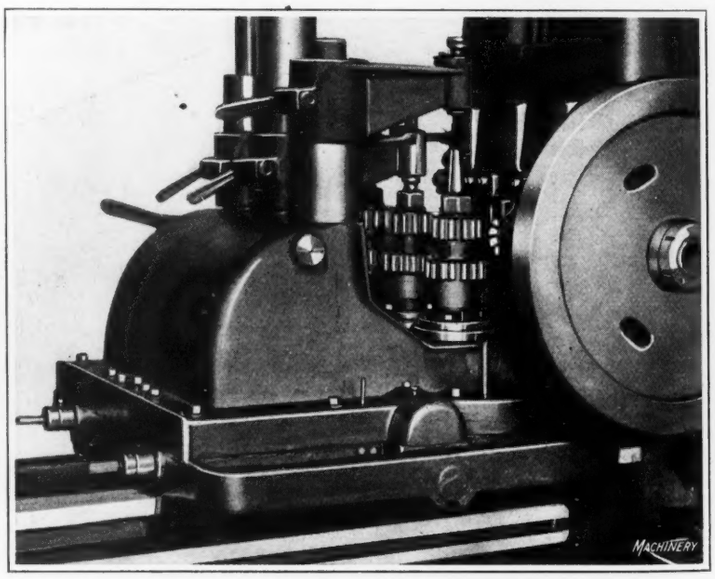


Fig. 13. Another Example of Multiple Gear-cutting

Rates of feed for the cutter-slides, in inches per minute, are given in the accompanying table, which applies to high-speed steel cutters and covers diametral pitches from 2 to 16. In determining the proper rate of feed by actual test, it is necessary, of course, to consider the amount of time the cutter may be used without regrinding, because the highest rate of feed that may be used for a short period is not necessarily the most economical rate.

Changing Rate of Feed when Using Double Cutters

The use of double cutters (one for roughing and the other for finishing) is considered advantageous in many shops when a large number of gears are to be cut, although this method is sometimes employed even when cutting a single gear. When taking the first cut, as illustrated in Fig. 7, both cutters must cut a tooth space through solid stock, whereas for the following cuts the finishing cutter simply removes what has been left by the roughing or stocking cutter. Because of this heavy cutting at the start, a slower feeding movement should be used, and to avoid feeding by hand or changing the gears, the Brown & Sharpe machine (Fig. 7) is equipped with a feed-changing mechanism, which automatically changes the slow feed used for the first cut to a feeding movement twice as fast for the remaining cuts. The feed is again reduced for taking the first cut on the next blank, by means of a hand-lever.

The cast-iron gear shown in Fig. 7 is to have 75 teeth of 2½ diametral pitch; the face width is 3½ inches. Cutters of 5¾ inches diameter operate at a speed of 66 revolutions per minute, or about 90 feet per minute at the pitch line, and the feeding movement after the first cut is 2¼ inches per minute. The time per gear is 3¾ hours.

Additional examples illustrating the use of roughing and finishing cutters at the same time are illustrated in Fig. 2, which shows two gear-cutting machines made by the Newark Gear Cutting Machine Co. of Newark, N. J. When taking the first cut through the solid rim, a relatively slow feed is used, and for all succeeding cuts, where only one cutter is cutting into the solid rim, a faster rate of feed is obtained simply by pulling the triple-geared feed knob out another notch. The large gear on the machine at the left has 150 teeth of 1¾ diametral pitch, and the gear at the right has 86 teeth of 1¼ diametral pitch. Both of these gears are made of cast steel.

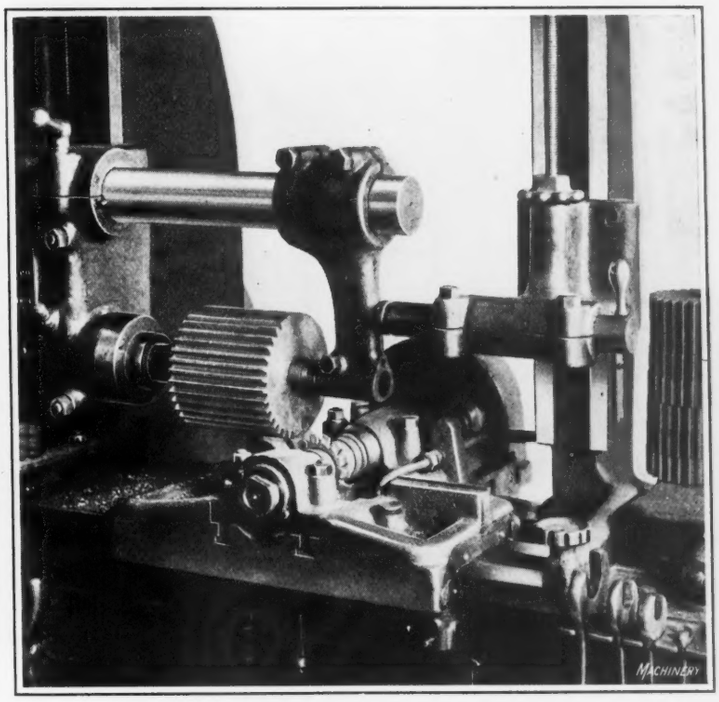


Fig. 14. Stack of Five Gears mounted on an Arbor

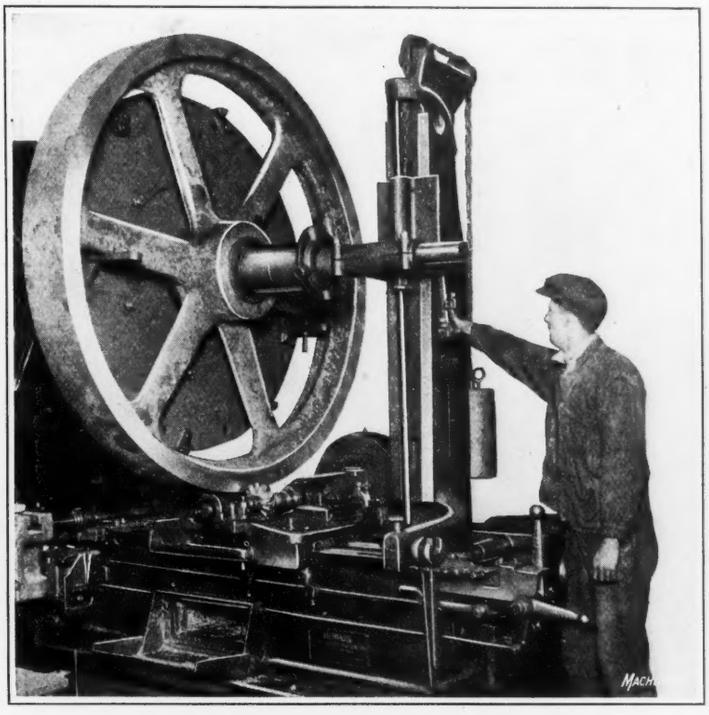


Fig. 15. Method of supporting a Fairly Large Gear

Adjustment for Tooth Depth, and Methods of Gaging

Adjustment for depth of cut is made by changing the position of the work-holding slide until the cutter (which should be revolving) just grazes the blank; the cutter is then withdrawn to clear the blank, and the slide carrying the work-spindle is adjusted an amount equal to the whole depth of the tooth, as shown by the graduated dial of the adjustment screw. The whole tooth depth equals 2.157 divided by the diametral pitch. In using this method, care should be taken to safeguard against errors which might result from lost motion between the adjusting screw and nut. The outside diameter of the gear blank should also be measured carefully, and an allowance made if it is not the correct size. The outside diameter of a spur gear is found by adding 2 to the number of teeth and dividing this sum by the diametral pitch.

A good method of checking the position of a cutter relative to the blank is by measuring the tooth thickness with a vernier gear-tooth caliper. This caliper measures the chordal thickness of the tooth at the pitch line. In order to use the caliper, it is necessary to know what the chordal thickness should be and also the perpendicular distance from the chord to the top of the tooth. These dimensions may be determined by formulas or by referring to tables to avoid calculations. (See formulas and tables in MACHINERY'S HANDBOOK, pages 589 to 591.)

Another method of gaging tooth depth is by first cutting two spaces in the blank diametrically opposite (assuming that the gear has an even number of teeth) and a little less than the correct depth. The root diameter is then measured, and

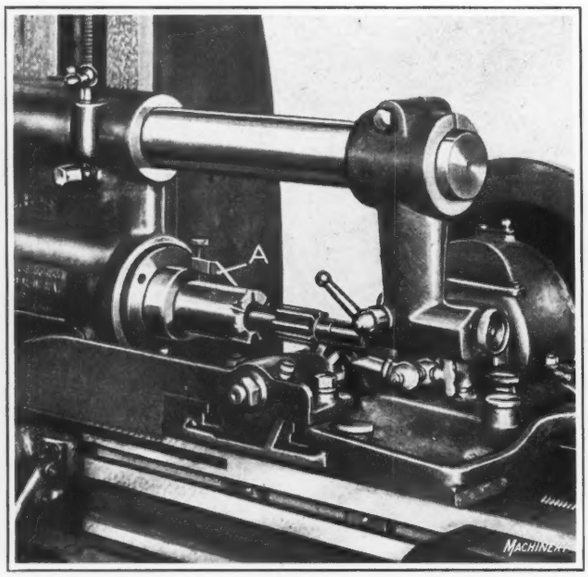


Fig. 16. Pinion held between Centers and aligned by Lever A engaging Keyway

the spaces are recut accordingly; the root diameter is again measured to check the accuracy of the adjustment. A special gage applied to the work-arbor is sometimes used for testing the depth of the cut, especially when cutting a number of duplicate gears.

Single and Block Systems of Indexing

Most gears are cut by indexing from one tooth to the next, but sometimes the index mechanism is arranged to rotate the blank an amount equal to two or more tooth spaces. This "block indexing" is done when using a gang of cutters, which finishes two or more teeth at one time. Block indexing may also be employed with a single cutter, as, for example, when every seventh tooth space is cut in a gear having 100 teeth. When this method is employed, the gear must make two or more complete revolutions in order to finish all the teeth. The object of this system of indexing is to distribute the heat generated by the gear-cutter, and secure greater accuracy and more rapid production. When the teeth are cut by indexing one tooth at a time, the tendency is toward local heating of the gear rim, especially if there is no provision for cooling the cutter and the work. Some compound is ordinarily used, however, for steel gears, and compressed air has been utilized when cutting cast-iron gears, although this is not the general practice. With block indexing, the total number of teeth in the gear must not be a multiple of the number of teeth indexed.

An example of intermittent or block indexing is shown in Fig. 9, which illustrates a roughing operation. A Brown & Sharpe machine is being used and also the improved stocking cutter made by this company. The stepped and plain teeth alternate, the stepped teeth projecting beyond the outline of the plain teeth just enough to break up the chips. This cutter enables comparatively heavy cuts and coarse feeds to be employed, and the intermittent indexing is adopted to prevent errors which might arise from local heating when taking the stocking cuts. This is a cast-iron gear having 124 teeth of 2 diametral pitch, and 6 inches face width. The cutting speed is 90 feet per minute, and the feed 3½ inches per minute. The roughing cuts are taken in six hours. Fig. 10 shows a machine finishing the same gear. The rate of feed for finishing is reduced to 1½ inches per minute.

Attachment for Cutting Quill Gears

Automatic gear-cutting machines are sometimes equipped with special attachments to adapt them for gear-cutting operations which otherwise could not be performed. One type of attachment is shown in Fig. 11. This attachment, which is for a Brown & Sharpe automatic gear-cutting machine, is clamped on the cutter-slide in place of the regular cutter-spindle bearing. The cutter-spindle of the attachment is elevated enough to permit cutting the teeth of the smaller member of the quill gear. This cutter is driven from the main spindle through a train of steel spur gears. Fig. 11 illustrates the cutting of a gear having 22 teeth of 4 diametral pitch and 2¼ inches face width. The cutter speed for roughing is 100 revolutions per minute, or 78 feet per minute, and the feed 2½ inches per minute. The time required for roughing varies from thirty-eight to forty minutes per gear. On the finishing cut the speed is reduced to 80 revolutions per minute, or 62 feet per minute, and a feed of 2 1/16 inches is used. The time required for the finishing operation on this job is forty-five minutes per gear.

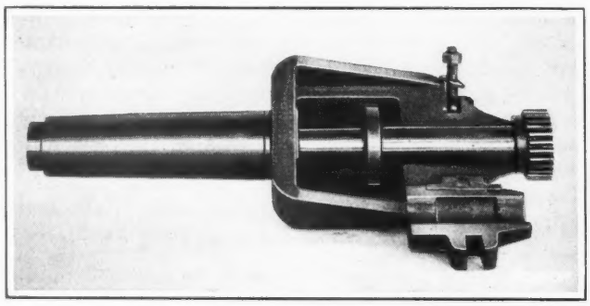


Fig. 17. Special Device for holding a Turret-driving Sleeve when cutting Gear Teeth

Cutting Spur Gears on Machines of the Multiple Type

Multiple types of gear-cutting machines are sometimes used when the production of duplicate gears is large enough to warrant installing a machine designed for multiple operation. Fig. 12 shows one of the vertical-cutting machines made by Gould & Eberhardt, Newark, N. J., which is arranged for cutting three steel pinions at the same time. In this particular instance, the pinions are roughed out on this machine and afterward finished on a gear-hobbing machine, but this type of machine is used also for finishing certain classes of gears.

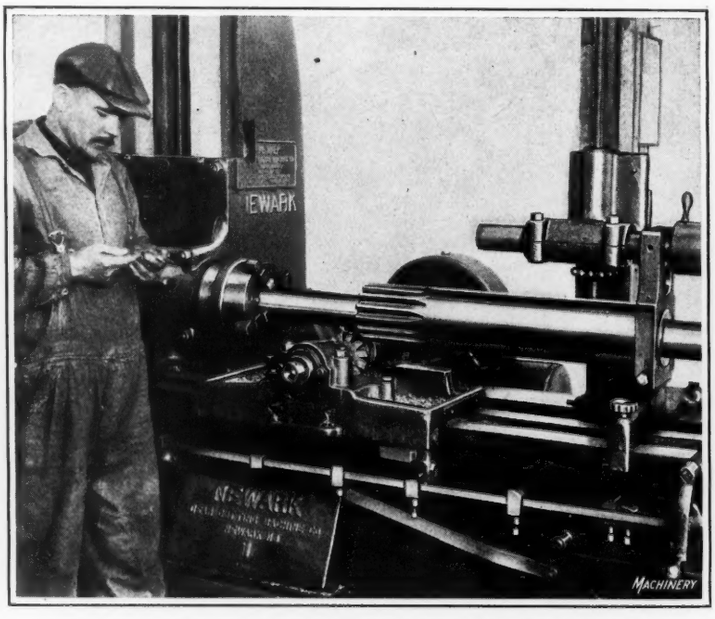


Fig. 18. Cutting a Pinion Integral with a Long Shaft

The pinions are held on a turret which is arranged to hold three on each side. As soon as the pinions on one side are cut, the turret is turned a half revolution, thus locating the uncut blanks opposite the cutters, which are at work while the operator is removing the finished pinions and replacing them with blanks. The support for the upper ends of the work-spindles is in one piece, and is raised for removing the pinions by turning the hand-lever seen in the illustration.

Another multiple gear-cutting operation on a Gould & Eberhardt machine is shown in Fig. 13. This machine is used for cutting three pinions simultaneously. These are double pinions, having twelve and sixteen teeth respectively of 3–4 pitch. Each work-spindle has independent adjustment toward or away from the cutters to compensate for any variations in the cutter diameters. Machines of this kind are intended especially for cutting the coarser variety of spur gears used in trucks and tractors.

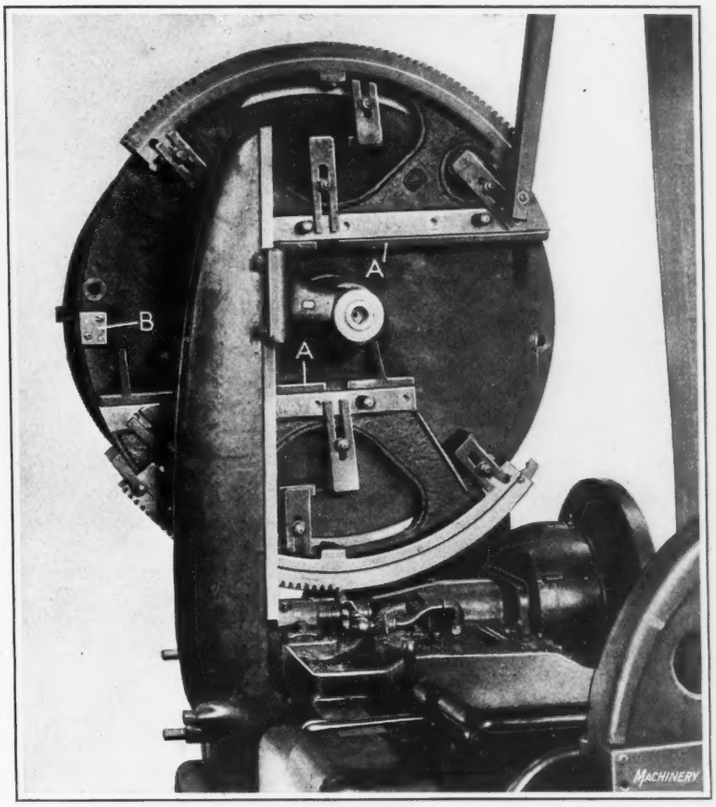


Fig. 19. Cutting Segment Gears which are held on a Special Fixture

Arbors and Fixtures for Holding Gear Blanks

The results obtained with gear-cutting machines may be decidedly affected by the method of holding and supporting gear blanks while cutting the teeth. Many inaccurate gears have been due entirely to poor chucking practice. The aim should be to hold the blanks rigidly but without distortion due to clamping stresses. If there is chattering, the cutter is dulled rapidly, the rate of production lowered, and the quality of the work affected. The size of the blank, its shape, and the shape of any section which may be cast integral with it, largely determine the method of chucking, which should be arranged to permit inserting and removing work readily.

The means regularly employed on automatic spur-gear cutting machines include the use of solid arbors, expanding arbors, arbors having stepped flanges or adapters for accommodating bores of different diameters, and special fixtures for large gears or odd shapes. The faceplate of the machine may be put on the spindle and used in conjunction with small jacks or supports placed at different points. The most important support, however, is the rim rest, which is so located as to prevent deflection due to the thrust of the cut, and should always be used if possible. A gear rim should run true to prevent binding against the rim rest, and it is well to apply a little oil to that side of the rim.

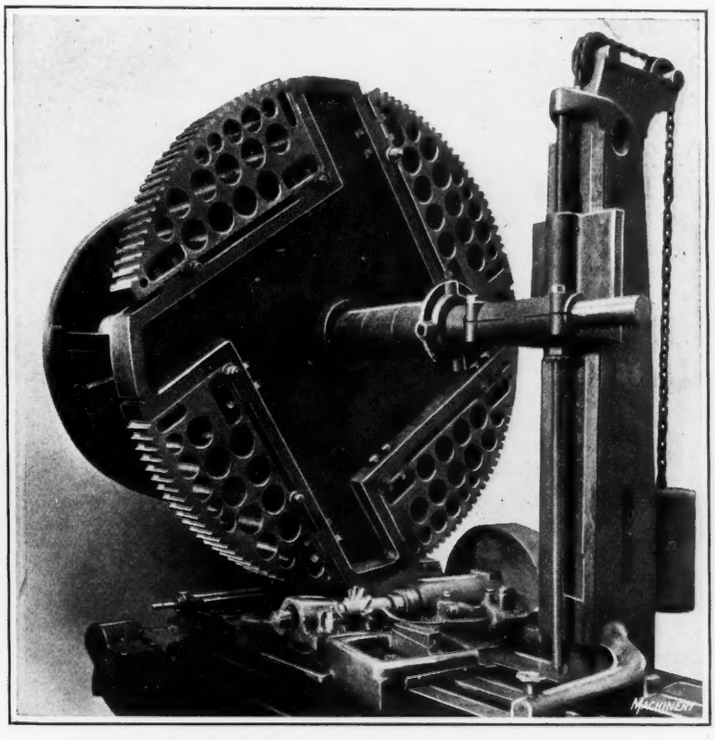


Fig. 20. Another Example of Segment Gear-cutting

Gear Blanks Mounted on Arbors

When cutting small and medium-sized gears it is common practice to cut two or more at the same time by clamping the blanks together in the form of a gang or stack. Fig. 14 shows five gears mounted on an arbor. This arbor has a taper shank which enters the hole in the machine spindle, and the outer end of the arbor is held by the overhanging supporting arm, which is also braced (in this particular instance) by the vertical box column support. The work-holding part of this arbor is straight, and the gears are clamped against the shoulder by a nut at the outer end of the arbor. When gears are held in this way, the rims should be faced true, because inaccuracies will tend to distort the arbor when the clamping nut is tightened. This illustration shows a Newark machine cutting cast-iron gears having 36 teeth of 6 diametral pitch and 1⅛ inch face width. By cutting the gears in gangs of five, a production rate of four minutes per gear is obtained. One cut is taken, and a high-speed steel cutter used. This cutter makes 142 revolutions per minute, and the feed of the carriage is 15 inches per minute.

Sometimes a gear is mounted on an ordinary lathe arbor, which is supported between centers. The arbor has a dog at one end so that it indexes around with the work-spindle. When cutting larger and heavier classes of gearing, the outer end of the arbor is frequently supported by a bearing instead of using a center. Fig. 15 shows a machine set up in this way. The outward bearing is adjustable along the vertical face of the

supporting column, so that it can be set in alignment with the arbor or work-spindle, the height of which varies, of course, for different sizes of gears.

The tractor pinion shown in the Brown & Sharpe machine in Fig. 16, is held between centers, the work being centered at each end. It was necessary in this case to align the teeth relative to a keyway, which is done by engaging the keyway with lever *A* pivoted to a sleeve into which one end of the pinion-shaft extends. Incidentally this stub-tooth pinion has 9 teeth of 7–9 pitch, and a face width of 2⅛ inches. It is made of low-carbon steel and one pinion is finished in five minutes, only one cut being taken for each tooth space. The high-speed cutter makes 166 revolutions per minute, or 120 feet per minute, and the feed is 9½ inches per minute.

Fig. 18 shows how a steel spur pinion was cut on a shaft 6 feet long in a Newark machine. On account of the length of this shaft, it would ordinarily have to be cut in a milling machine unless a gear-cutting machine were available with a large enough hole in the work-spindle to take the shaft. In this particular instance, a gear-cutting machine was used by holding one end of the shaft in a chuck screwed on the work-spindle, and the outer end by a bearing attached to the box column support. The feeding movement of the cutter-slide was reversed because the work was too long to feed the cutter forward.

A special holding device used when cutting the teeth on a turret-driving sleeve is shown in Fig. 17. The work is held in place by the hinge cover, which is shown in the open position. This fixture has a taper shank which fits into the spindle of the machine.

Fixtures for Holding Segment Gears

The special fixture shown in Fig. 19 applied to a Brown & Sharpe machine is used for holding two segment gears used in the elevating mechanism of anti-aircraft guns. Great accuracy was required for these parts, and the fixture is designed to hold each of the segments in the same relative position. As the illustration shows, each segment not only fits around the periphery of the fixture or faceplate, but is also located against a projecting ledge or shelf *A* extending along the side of the fixture. The block *B* is used for locating purposes to insure obtaining segment gears which are as near exact duplicates as possible. These segments each have 60 teeth of 4 diametral pitch, and 3 inches face width. Roughing and finishing cuts are taken. The speed for roughing is 57 revolutions per minute or 75 feet per minute, and the feed 1½ inches per minute. The roughing time is seven hours for the two segments. The cutting speed for finishing is the same as for roughing, but the feed is reduced to one inch per minute, and the time is ten hours for finishing the two segments.

Another example of segment gear work is shown in Fig. 20. These segment gears are for the elevating mechanism of 9.2-inch howitzers. As will be seen by referring to the illustration, four segments are mounted on the fixture and are accurately located by bolting them against finished seats. The teeth in this case were cut to a special pitch, and the work was performed at the plant of the Earle Gear & Machine Co. in Philadelphia, Pa.

* * *

THE DeLAMATER-ERICSSON MEMORIAL

The DeLamater-Ericsson Tablet Committee announces that it has had a communication from the Association of Swedish Engineers, Stockholm, Sweden, stating that the association will hold a celebration of the sixtieth anniversary of the battle of the *Monitor* and *Merrimac* simultaneously with the celebration which will be held in New York and Washington on March 9, when tablets in commemoration of the work of Ericsson and DeLamater will be unveiled at four different places in New York City, as mentioned in the December number of MACHINERY, page 312.

ANNUAL MEETING OF AMERICAN ENGINEERING COUNCIL

The American Engineering Council, the governing body of the Federated Engineering Societies, at its first annual meeting at Washington, January 5 and 6, made plans for the coming year. Dean Mortimer E. Cooley of the University of Michigan, president of the Federated Societies, presided. Dexter S. Kimball, dean of the College of Engineering, Cornell University, who is also president of the American Society of Mechanical Engineers, was elected one of the vice-presidents of the Federated Societies. Among the questions discussed was the principle of licensing or registering engineers. The secretary's report showed that the membership of the society is now composed of eight national and twenty state and local engineering societies.

The council voted to continue its support of the legislation for the relief of the United States Patent Office as reported in the Lampert bill. A report of the committee described conditions in the Patent Office as alarming. It was brought out by this report that one of the leaders of the House opposed the bill on the ground that it carried salaries higher than those paid for similar service in other departments of the Government. The chairman of the council's patent committee showed that there were many government positions involving legal or scientific knowledge that carried salaries above those requested for the Patent Office examiners, and demonstrated that the Patent Office examining force would be disintegrated if the matter were not soon adjusted.

* * *

SAFETY AND HEALTH WORK IN THE INDUSTRIES

A constructive article on the importance of safe and healthy working conditions in the industries appears in the December number of *The Nation's Health*, written by Otto P. Geier, M.D., of Cincinnati, Ohio, in charge of the health and safety work at the plant of the Cincinnati Milling Machine Co. The article points specifically to the value of hygienic and safe working conditions in producing better workers and better citizens. It is urged that safely guarded modern machinery, education in safety, clean working conditions, adequate ventilation and lighting, reasonable comforts and conveniences, and a fair wage system make for better efficiency, teamwork, and individual responsibility. On the other hand, Dr. Geier points out that unsafe and unclean working conditions, frequent accidents, careless treatment of employes, driving rather than leading, and slipshod wage systems produce constant dissatisfaction and irritability, affecting both the mental and physical state of health of the individual.

A health exposition was recently held in Cincinnati, which showed the work of the industrial physician. The article referred to places the information gathered relating to industrial relations, health and safety work at this health exposition at the disposal of executives in the industries in an interesting and instructive form. Reprints of the article, which should prove of great value to manufacturers in general, may be obtained from the Cincinnati Milling Machine Co., Cincinnati, Ohio, upon request. The article is distinctly constructive in its tendencies, and should prove helpful to many manufacturers who are realizing the importance of constructive work to counteract the pleas of agitators who are endeavoring to produce strife and discontent.

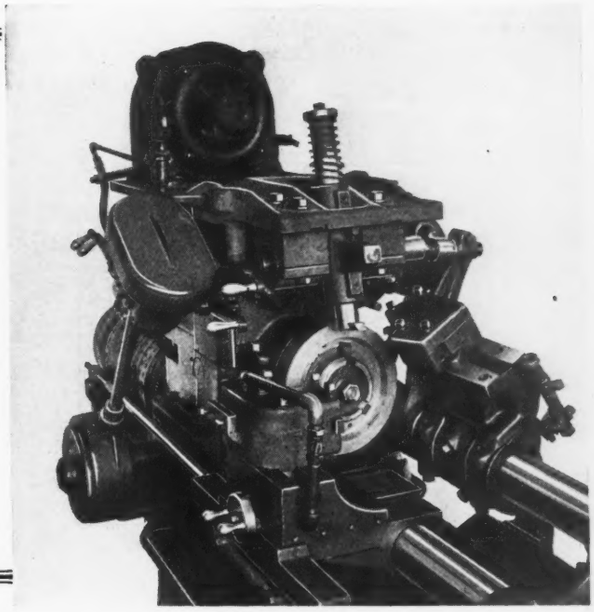
* * *

Building construction in Germany has increased steadily since 1919, according to an item in a Commerce Report. Figures for the first quarter of 1921 show that 5402 buildings were completed during that period, as against 1063 in the same period of 1919. The larger proportion of the buildings constructed were dwellings.

Tooling Equipment for Automobile Gears and Ball Races

Second of Two Articles Dealing with the Production of Automobile Gears

By RALPH E. FLANDERS
Manager, Jones & Lamson Machine Co., Springfield, Vt.



IN the preceding article on the machining of automobile gears, published in January MACHINERY, the operations dealt with were those in which Fay automatic lathes and double-spindle production lathes were employed. In the present article, the examples will include jobs performed on Fay automatic lathes and, in addition, operations on double-spindle flat turret lathes and Hartness automatic lathes.

Operations on a Camshaft Gear

The tooling equipments employed in machining a camshaft gear are shown in Figs. 2 and 3. Although the part is simple in construction, the example will serve to illustrate two or three points of importance. The first operation is performed on a double-spindle flat turret lathe provided with the tooling equipment shown in Fig. 2. The drilling and rough-boring are done in the first position. The rough- and finish-facing steps performed by tools in the second and third positions are effected by the use of the cross-sliding head. In the rough-facing step, the head feeds away from the operator, while in the finish-facing step it is returned. By this arrangement, there are no idle movements of the cross-sliding head. This is a principle of universal application to work of this kind, and it should always be observed.

The reamer shown in the fourth position carries a back-facing tool through its center. The inner side of the hub is faced with this tool for a short distance before the reamer reaches the work. The production on this operation is from thirty-four to thirty-six pieces per hour. The reason for back-facing the hub will be apparent by reference to Fig. 3, which shows the tool set-up used in completing the part in a Fay automatic lathe. The back-facing tool cuts slightly below the finished thickness of the hub and so provides a seat for the clamping nut of the arbor. On parts to be machined in this way, it would be well for a designer to specify back-facing on the drawing, but when this is not done, arrangements can usually be made for taking this cut.

Prior to the operation on the Fay automatic, the small holes around the hub center are drilled. These are utilized in the operation on the automatic lathe, dowel-pins being provided in the arbor which fit into the small holes for driving the part. On work of this kind, broaching, drilling, or keyseating should be done before turning, in order that adequate driving means may be obtained. There are two machines provided with the tooling shown in Fig. 3, and these are run by the same operator. One machine roughs the work and the other finishes it. The output is thirty complete parts per hour.

The writer is inclined to criticize this set-up on the score of having too short an arbor. While the shortness adds to the stiffness, it tends to displace the rim more for a given inaccuracy of centers or of the arbor. In general, the all-over length of an arbor ought to be at least twice the diameter of the work. The small size of the center hole, of course, makes it impossible to put two or more pieces on the arbor at a time. Camshaft gears are the most difficult to get running quietly of any of the gears used in automobile construction, and so every precaution should be taken to procure smooth running. The finishing of gears on a true arbor is a long step toward this end.

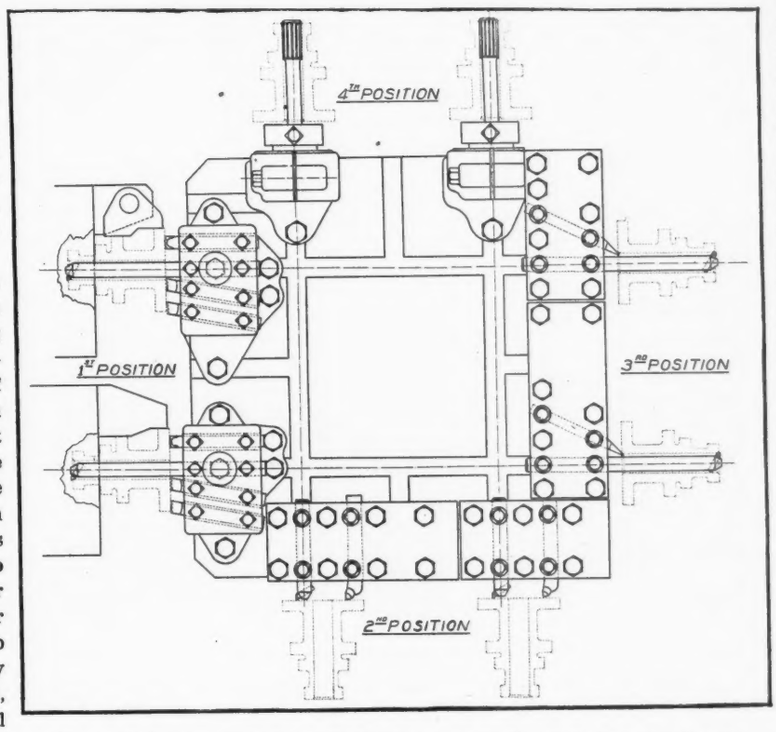


Fig. 1. Tooling for machining a Cluster Gear on a Double-spindle Flat Turret Lathe

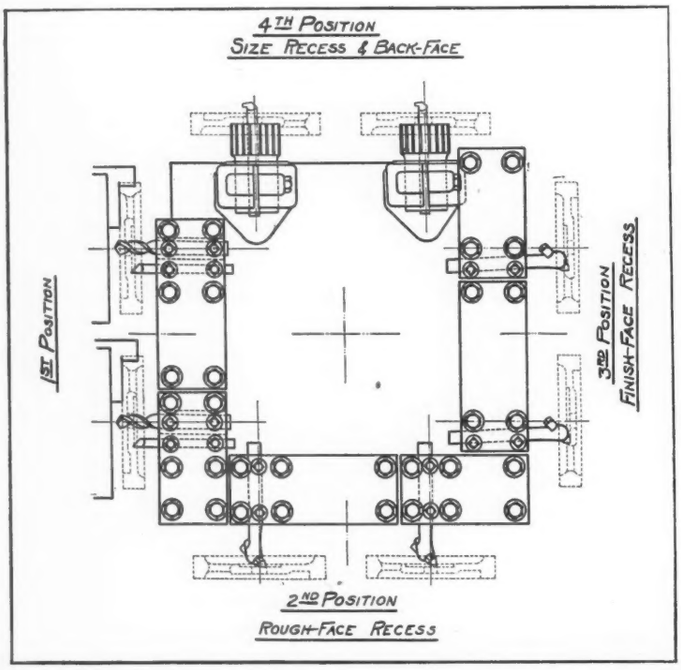


Fig. 2. Tooling used on a Double-spindle Flat Turret Lathe for producing a Camshaft Gear

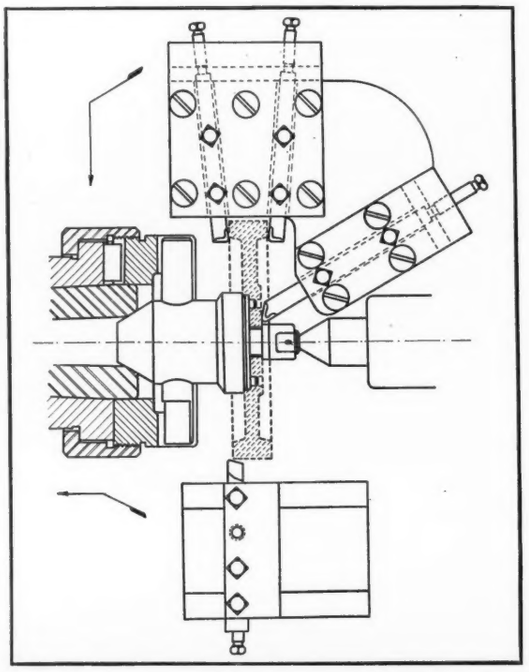


Fig. 3. Facing Hub and Rim Sides of Camshaft Gear on a Fay Automatic

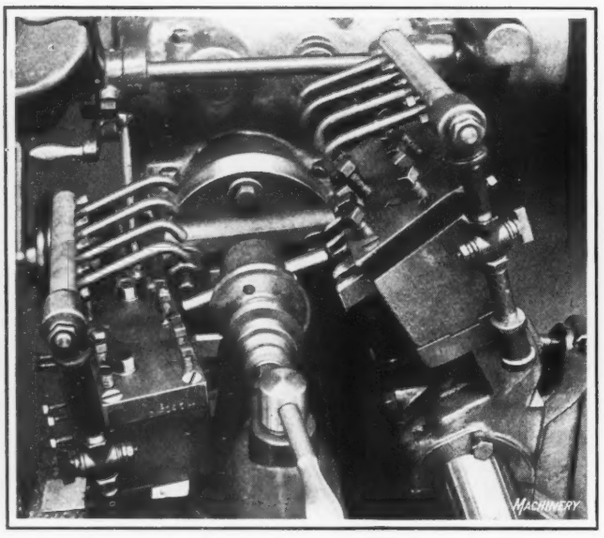


Fig. 4. Machine equipped for taking the Turning and Forming Cuts on a Cluster Gear

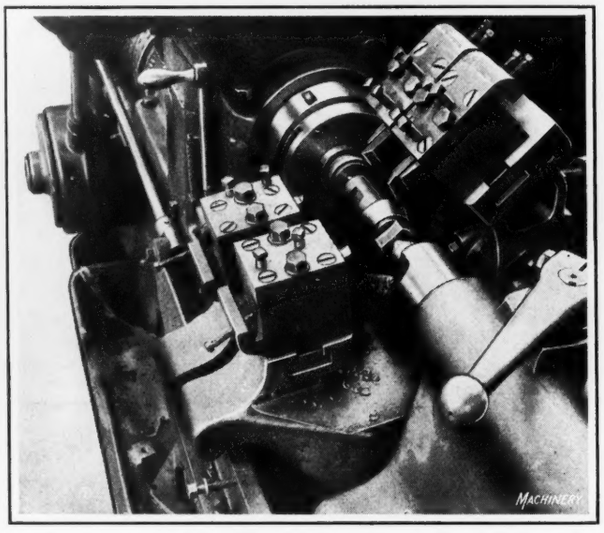


Fig. 5. Close-up View of Machine provided with the Tooling for a Small Bevel Pinion

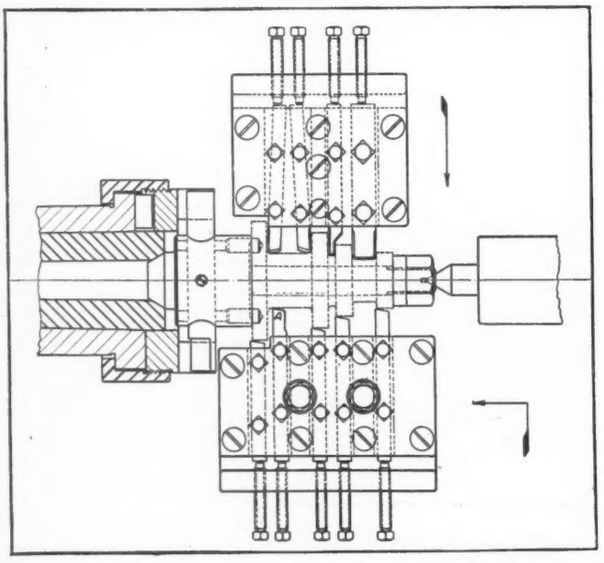


Fig. 6. Equipment for turning and forming the Cluster Gear shown in Fig. 1

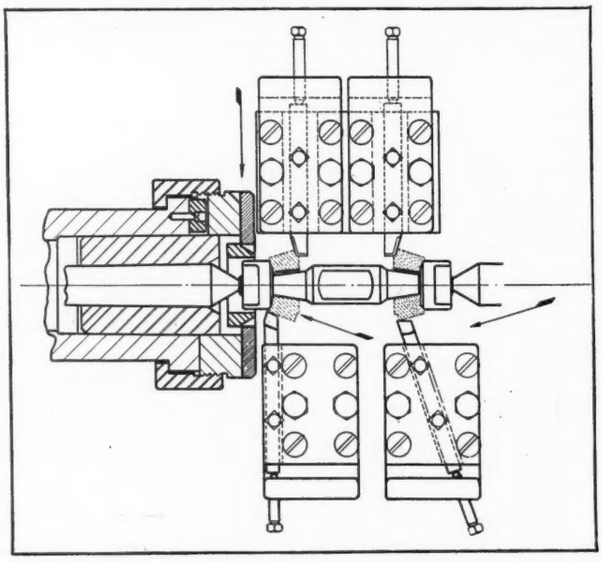


Fig. 7. Turning Small Bevel Pinion on a Special Double-carriage Fay Automatic Lathe

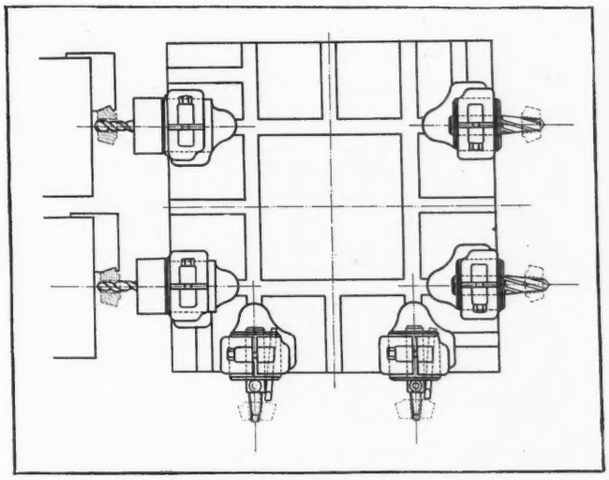


Fig. 8. Double-spindle Turret Lathe set up for machining the Taper Hole and butt-facing the Hub of a Bevel Pinion

The bend in the arrow at the side of the rear tool-holder indicates the feeding movements required for this tool to prevent the hub facing tool from coming in contact with the rim of the work.

Equipments for Machining a Cluster Gear

Another characteristic gear in automobile drives is the cluster gear commonly used on the transmission jackshaft in place of a set of separate gears employed in older practice. Improved methods of forging, machining, and gear-cutting have made possible this greatly simplified construction. In the process here dealt with, the forging first has the central hole rough-drilled in a heavy-duty drilling machine and then comes to a double-spindle flat turret lathe provided with the tooling shown in Fig. 1. On this machine the hole is rough-bored and the part is rough-faced at the large end by scale-breaking tools, as shown at Position 1. A straight longitudinal feed, under a heavy cutting power, is used for this operation. The tools in the second position finish-face the end, the total cut being divided between two tools on each piece in order to shorten the operation. One tool works from the periphery of the part toward the center, and the other cuts from the center toward the outside. The tools in the third position finish-bore and chamfer the hole, and the reamer shown in the fourth position takes the final cut in the hole.

The blank has two holes drilled in the faced end for driving purposes, in a later operation, and is then mounted on a vertical arbor on a drilling machine and has the small end butt-faced. The work is now ready for the outside turning, and this is done in a Fay automatic lathe furnished with the tooling shown in Fig. 6. The arbor construction provides two driving pins to engage the holes drilled in the face of the gear blank, as previously explained. The hole of this gear does not have a keyway, and so this special means must be taken to furnish a drive which will stand the heavy torque imposed by the large number of tools used. The front tool-holder rocks in rapidly and then feeds toward the left, tool *A* turning the neck and the other tools the outside diameters. The rear tool-holder rocks in and faces and forms the various surfaces as shown. Another operation very similar to this is illustrated in Fig. 4. Two machines are used, one for roughing and the other for finishing. The production with rough forged blanks is from twelve to fifteen pieces per hour. This requires up to 15 horsepower for driving the machine.

Production of Rear-axle Drive Bevel Pinion

The machining of a separate type of rear-axle drive bevel pinion is an interesting job on account of the high production possible. The blanks are forgings and have the taper holes machined and the rear hub butt-faced in a double-spindle turret lathe furnished with the tooling shown in Fig. 8. The output of this operation is from eighty-five to ninety pieces per hour, and it should be possible to increase this somewhat with the development of a production lathe having three tool positions on a cross-slide. The blanks go next to a drilling machine to be butt-faced at the small end in the same manner as described in connection with transmission gears in the article "Cost-reducing Tooling Equipment," in January MACHINERY.

The turning operation is performed on a special double-carriage Fay automatic lathe having the tooling illustrated in Fig. 7, the two front tool-holders feeding independently in the direction indicated by the arrows. The rear tool-holders form the back of the work to the angle shown. In one automobile shop where only one cut is taken over the gears, an output of 1100 pieces in eight hours has been obtained. One machine keeps an operator busy at this rate, and he requires a helper for loading the arbors. Ordinarily, of course, two machines would be used, one for roughing and the other for finishing the work. A machine set up for a similar gear is shown in Fig. 5.

Machining a Ring Bevel Gear

The first operation on a ring bevel gear is performed on a Hartness automatic, a machine which was designed especially to embody the principle of intensive tooling. Fig. 9 shows a gear of a conventional design being produced on this machine. The operation consists of rough- and finish-facing the back and the recessed seat, and back-facing the inside of the flange. All this is done by tools in the lower holder which swings to one side for the roughing cuts and to the other side for the finishing cuts. The upper tool-holder carries cutters for rough- and finish-boring, necking, and chamfering. The hole is rough- and finish-bored by one

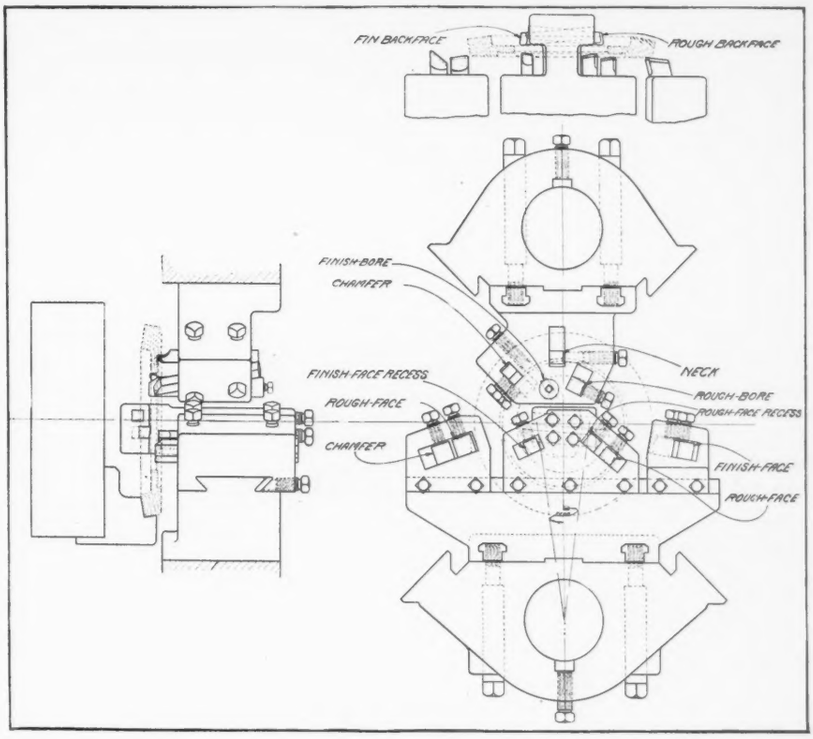


Fig. 9. Hartness Automatic set up for machining a Ring Bevel Gear

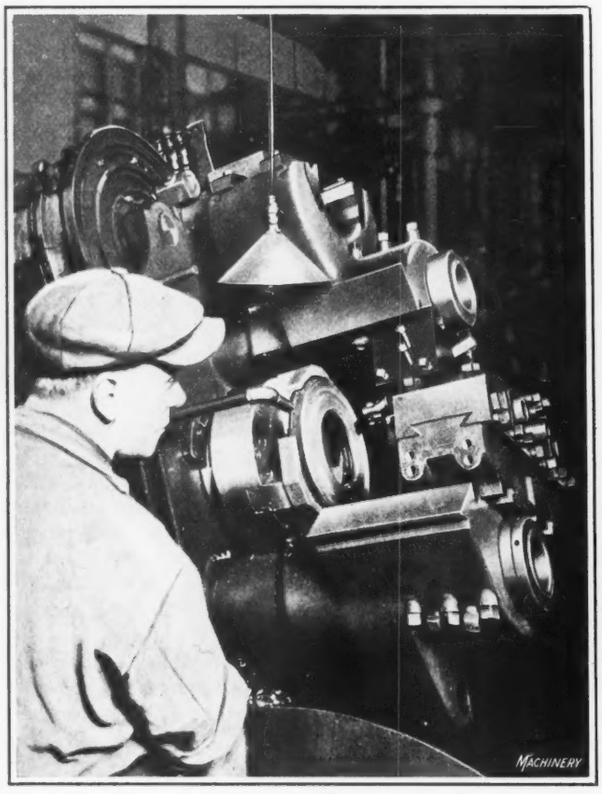


Fig. 10. Hartness Automatic provided with the Tooling for machining a Ring Bevel Gear, shown in Fig. 9

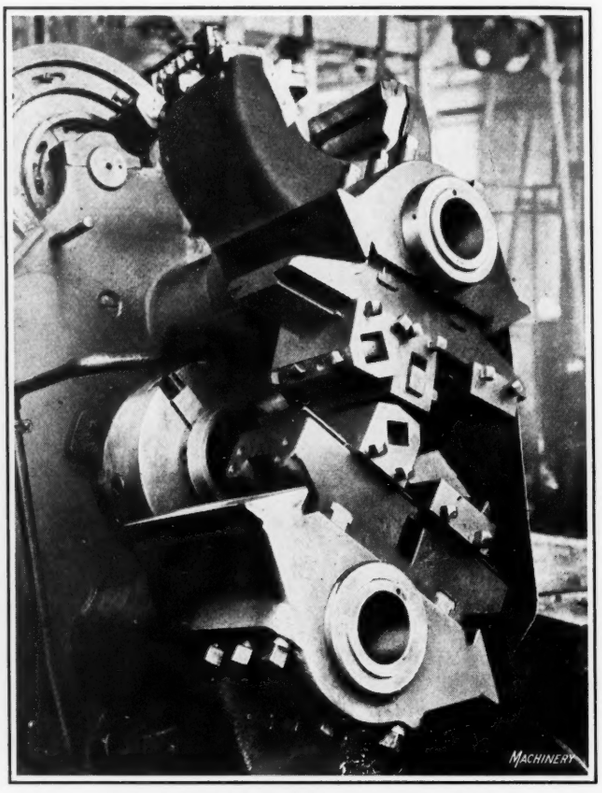


Fig. 11. Close-up View of the Equipment used in machining a Ball Bearing Race, shown in Fig. 13

feeding movement, the finishing tool following the roughing one. An accuracy of 0.001 inch can be constantly maintained in this operation. The output varies from twelve to twenty pieces per hour, depending on the size of the gear and the material from which it is made. The higher figure is obtained with a 10-inch drop-forged gear of mild steel, which is annealed, and intended to be carburized and heat-treated.

This set-up, which is also shown in Fig. 10, is an excellent example of concentrated tooling with idle movements eliminated. An operator is kept busy attending two of these machines on ordinary work. The blank next has holes drilled in the web and is then ready for an operation performed in a Fay automatic lathe provided with the equipment shown in Fig. 12 and in the heading illustration. Referring first to Fig. 12, it will be noted that the work is held in place against a hardened seat by a quick air-operated fixture, and is driven by dowels engaging the holes drilled in the web. The tools in the front holder rough- and finish-turn the outside diameter and finish-face the surface which will later be the inner end of the teeth. The tools in the rear holder rough the bevel face of the gear and round its back corner.

As plainly shown in the heading illustration, a tool is carried in an overhead slide provided for finishing the face of the gear. Since this slide is mounted independently of the arm on which the rear tool-holder is located and has a separate connection to the cam-drum, it is possible for the face finishing tool to follow right behind the roughing cut on this surface without its accuracy being affected by the heavy strains of the roughing cut. This arrangement, therefore, permits all cuts to be taken simultaneously, and in practically the time needed for the longest cut, which is that of rough-facing the bevel surface. The output per machine is from twelve to twenty gears per hour, depending upon the size and material. One operator can usually run two machines.

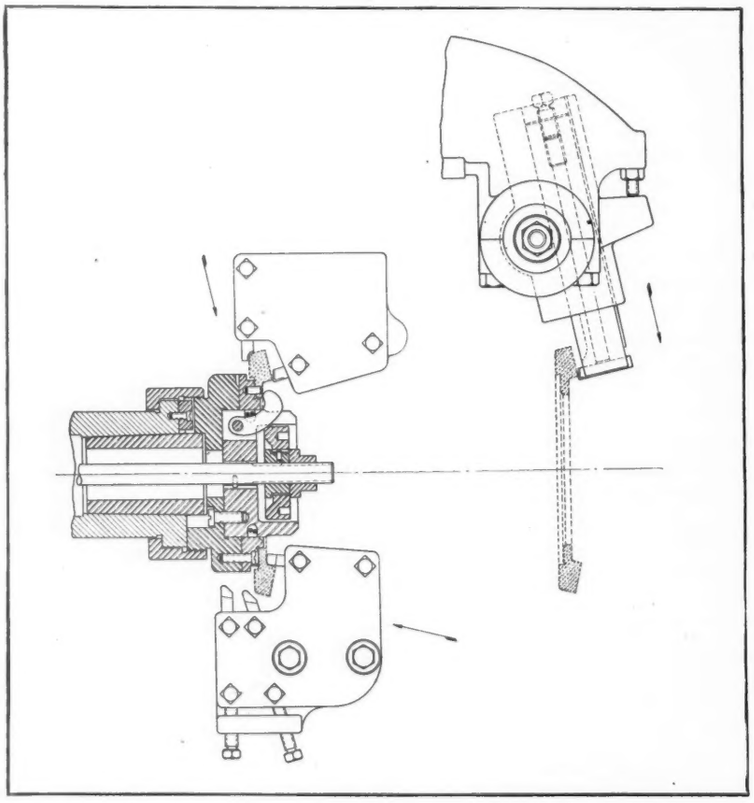


Fig. 12. Example in which the Work is held on an Air-operated Fixture and driven by Dowels engaging Holes in the Web

Tooling for Finishing Ball Bearing Races

The machining of an outside race for a large ball bearing is accomplished in Hartness automatics by

the use of the tooling equipments shown in Figs. 11, 13, and 14. The blank is a forged ring made of a special steel alloy and is somewhat difficult to machine. In the first operation, the forging is held from the inside by the swivel jaws of a three-jaw chuck, as shown in Fig. 13. This gives six points of clamping in all, and makes it possible to tighten the jaws sufficiently for taking heavy cuts without distorting the work. From the tooling arrangement it will be seen that the part is bored half way through on this machine. The reason for this is that it requires no extra time, as it is done while the outside of the part is being turned, and it materially shortens the time necessary for the succeeding operation. A close-up view of this set-up is shown in Fig. 11. When the upper holder is fed in, it bores the hole and rough-turns the outside. It then swings to the left and finish-turns the outside while being fed back. The lower holder swings to the left and faces the part on one end, chamfers the hole, and rounds the outside corner. This completes the first series of operations on the part.

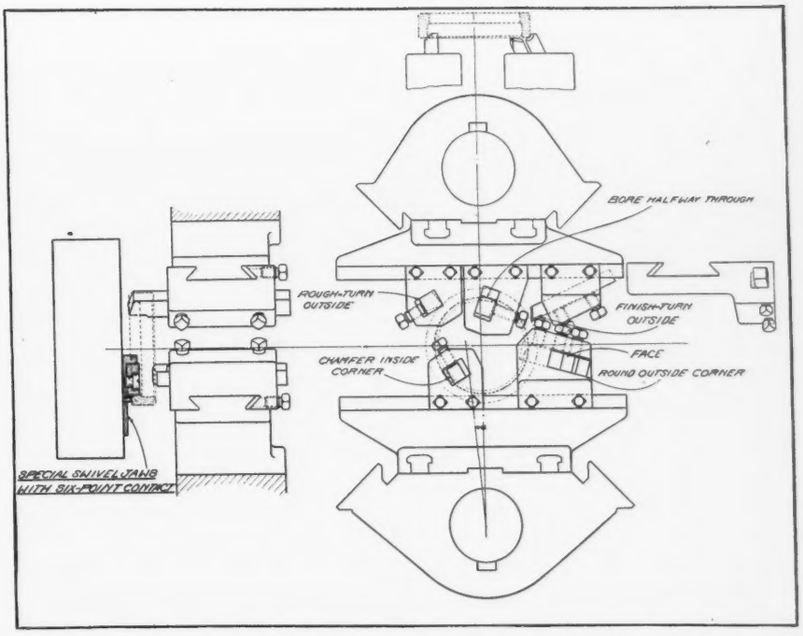


Fig. 13. Diagrammatic Illustration of the Tooling on the Machine shown in Fig. 11

Tooling for Second Series of Operations on Ball Bearing Races

Fig. 14 shows the tooling for the second series of operations. The work is held in accurately bored soft jaws which grip it on the finished outside. The lower tool-holder carries a facing tool only. The upper holder first feeds directly in and completes the boring of the unfinished half of the hole. It then swings toward the left and rough-grooves and finish-grooves the part, and chamfers and rounds the corners. The finish-grooving tool is mounted a greater radial distance from the center about which the holder oscillates than the rough-grooving tool, their relative positions being such that for a given angular swing of the holder, the finishing tool travels faster than the roughing tool and thus tends to overtake the latter. By this means, the roughing and finishing cuts are taken in one continuous movement by two separate tools mounted in the same holder.

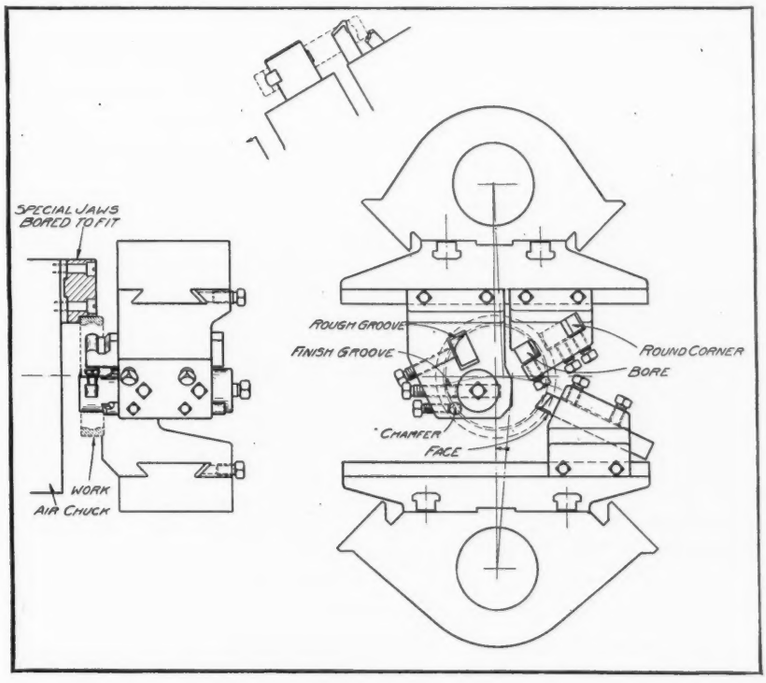


Fig. 14. Tooling employed in the Second Operation on the Ball Race which is also performed on a Hartness Automatic

MEETING OF AUTOMOTIVE ENGINEERS

At the annual meeting of the Society of Automotive Engineers held in the Engineering Societies' Bldg., 29 W. 39th St., New York City, January 10 to 13, a great many interesting papers were read. Those of especial interest to MACHINERY's readers were "Chrome-Molybdenum-Steel Application from the Consumer's Viewpoint," by C. N. Dawe; "Continuous Die Rolling," by G. R. Norton; "Drop-forging Practice," by J. H. Nelson; and "Pertinent Facts Concerning Malleable-iron Castings," by Enrique Touceda. These papers were all read at the Materials Session.

A Standards Committee meeting was held in connection with the annual meeting, at which sixteen divisions of the Standards Committee presented reports, including the committees on ball and roller bearings, chain, iron and steel, non-ferrous metals, parts and fittings, and screw threads. Other sessions of the meeting were devoted to airplane engines, body engineering, motor truck transportation, lubrication, research, fuel and engines, with a special session on passenger cars. The papers that were read before the meeting are published in the Journal of the Society of Automotive Engineers.

* * *

NEW CLASSIFICATIONS FOR EXPORT STATISTICS

Beginning January 1, the Department of Commerce will employ new classifications for its export statistics. The new classifications go into considerably greater detail as to the classes and types of machinery exported. In the metal-working machinery field, for example, the classifications will cover specifically lathes; boring and drilling machines; planers, shapers and slotters; bending and power presses; gear-cutting machines; milling machines; sawing machines; thread-cutting and screw machines; punching and shearing machines; power hammers; rolling machines; wire-drawing machines; polishing and burnishing machines; sharpening and grinding machines; foundry and molding machinery; and other metal-working machinery. In addition, there will be a sub-division for chucks; another for reamers, cutters, and drills; and one for pneumatic portable tools.

Aggressive Machine Tool Salesmen

By a Machine Tool Sales Manager

THE traveling of the machine tool salesman from shop to shop, calling upon his customers and those whom he hopes to make his customers, is the aggressive part of machine tool salesmanship—the very life of the business. The aggressive salesman realizes that the shop man buys a machine tool, not when the actual order is written out, but when he has been convinced of the desirability of acquiring a machine that he needs. Too many machine tool salesmen sit back comfortably with the thought that when their customers—their personal friends—are ready to buy, they will let them know. Such salesmen not only neglect their own personal interest, but they also fail to avail themselves of their opportunity to benefit both their customers and the manufacturers whose tools they are distributing.

A System of Successful Salesmanship

The system used by a successful machine tool salesman is an example of efficient salesmanship. This man keeps a memorandum book in which he divides his prospects into three classes: (1) Those ready for closing; (2) those active and interested; and (3) those worth cultivating. In the first list he keeps the names of all those for whom he has orders pending and who are ready for closing the sale. They receive his first attention. Every day he looks over this list, and asks himself if there is anything that he can do that day toward getting the final order; if so, he does it. He passes up other probable orders, if necessary, in order to devote himself to the actual possibilities of the day.

After the names in the first class have been attended to, he takes up the second list—the active prospects. These are concerns that he feels it will pay him to cultivate intensively, because there are machines that they should buy, because their industry is enjoying sufficient prosperity to make expansion likely, or because there is a probability of a change in the product, requiring new equipment. His efforts are devoted to bringing this second class of prospects into the first class of probabilities. If time permits, he takes up those on the third list, making a friendly call upon those that are merely prospects worth cultivating, with the aim of transferring them to his second list.

This salesman claims that his system produces very satisfactory results, and enables him to accomplish more each day than he would otherwise find time to do.

How Machine Tool Salesmen are Received

The writer of this article at one time occupied a position in which it was his duty to receive machine tool salesmen. It was the policy of the firm to receive everybody, and to answer every letter that called for an answer. Sometimes this policy becomes irksome to the man who has to receive all visitors with something to sell, and it is not carried out to the letter of the law.

The reception of a machine tool salesman depends largely upon the general condition of business. When a firm is quietly studying new methods or contemplating a change in design, the machine tool salesman is most welcome; but most of the tools bought when business is less pressing are selected because of the "missionary" calls made by salesmen at a previous time.

It is commonly stated by machine tool salesmen that when a concern issues a list, the tools are already selected, and in the experience of the writer, this is true. It may not always be true, but unless the sending out of the list develops some unexpected information, the tools in mind when the lists are circulated are generally the tools purchased. When the lists specify a 16-inch lathe of a given make, "or equal to it," it is almost certain that the prospective buyer believes that the machine made by the firm whose name he has quoted has no equal for his particular work.

Visiting New Prospects

It is the visits of the machine tool salesmen in apparently quiet times that actually build business for them. It is the "fill in" calls that start the ball rolling, and those calls require the greatest experience and diplomacy to prevent them from becoming irksome to the prospective purchaser because of their aimlessness. They are calls without an apparent reason. The salesman makes the prospective customer feel that he wants at least an inquiry, if not an order, at a time when there is no reason for either. There is no particular point to the talk. The customer is asked how his health is, how business is, and if he won't remember them when he is in the market for something.

Now, in justice to the machine tool salesman, it must be admitted that the hardest problem, when there are no immediate prospects of sales, is to find something to talk about. He sometimes will hesitate to call upon a prospect because he is unable to find the right subject to bring up, knowing that there is no immediate business. Nevertheless he should see the prospect. The average machine tool salesman makes a mistake in dealing with too many subjects at one time. It would be much better for him to stick to one theme in striving to make an impression on a prospect, considering the subject from different angles. The salesman can talk about his prospect's product. He can ask how this or that operation is performed in the customer's shop. In this way he gains much information, and he may be able to make suggestions that would prove of value. There are times when the customer does not feel like talking. It then becomes the salesman's job to arouse his interest.

Subjects of Interest to the Customer

There are many things that a salesman may speak of to interest his prospect, but he should avoid discussing all of them at one time. He makes a great many calls and can choose one subject for each call. The salesman can talk about his firm. He can explain the policy of the manufacturer he represents and the things that his firm is able and willing to do in an effort to help the customer. It is as important to impress upon the customer that the manufacturer's policy is a liberal one as that the machinery itself is of the right quality; but in order that such talk may be of value, it must be sincere and based upon the earnest convictions of the salesman. A testimonial letter from a reputable firm is a worthy means of creating a lasting impression. Automobile salesmen use such means effectively; why should not machine tool salesmen use them also? There is nothing that a customer likes to know more than that the machine he plans to buy has given satisfaction elsewhere. A point that salesmen should remember is that when they hand a prospective customer a testimonial letter to read, they should keep quiet while the prospect reads it.

Interesting incidents are often effective as a basis for an impressive interview. Back of the design or the evolution of most machine tools there is a story of how and for what reason they were designed. There is a personal interest in such incidents. Not only does one remember the tools because of the story, but one usually remembers who told the

story. Hence, a double purpose is gained; the machine will be remembered and the salesman as well.

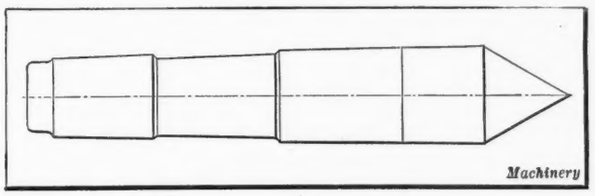
Actual increases in production effected in other plants with the machines offered for sale are always of interest, but the salesman should be careful to be accurate in all such statements and to avoid exaggerations. Reasons for the increase should be given, which leads to an explanation of the merits of the machine and special features of its design.

Briefly, a machine tool salesman, in order to make his calls worth while, must be able to use the prospective customer's time to some good purpose, and that can only be done by a thorough knowledge of the goods that he has to sell and a systematic distribution of that knowledge.

* * *

SHOULD CENTERS BE RELIEVED?

In the manufacture of "Red E" high-speed centers we are looking for improvements that will meet the needs of our customers. We have had under consideration for some time a change in design in which the centers would be relieved



Relieved High-speed Lathe Center

somewhat along the lines shown, slightly exaggerated, in the accompanying illustration. The method may have both advantages and disadvantages, and it would be of great interest to hear from the readers of MACHINERY as to their opinions of relieved centers.

THOMAS FISH
President, The Ready Tool Co.

Bridgeport, Conn.

* * *

WAGES IN GERMAN MACHINE INDUSTRIES

The table below shows a comparison of hourly wages paid in the machine-building industry in Chemnitz, Germany, previous to the war and since January 1, 1922. In the present agreement on wages of workers in the metal industries, a basic hourly rate is fixed, and the worker receives a certain additional rate on account of the high cost of living. In the table these two items are added together. Furthermore, skilled workmen who are always employed at an hourly rate (not on piece-work) receive an additional amount which has also been included in the figures given. In figuring present exchange, 1 mark has been assumed to be equal to 0.6 cent.

Class of Worker	Age	1922		1914	
		Marks	Dollars, Present Exchange	Marks	Dollars, 1914 Exchange
Toolmakers, Patternmakers, Molders, Highly Skilled Operators	over 25	11.20	0.07	0.60	0.15
	21-25	9.85	0.06	0.60	0.15
	19-21	8.50	0.05	0.60	0.15
	17-19	6.29	0.04	0.60	0.15
Machine Operators	over 25	9.50	0.06	0.50	0.12½
	21-25	8.25	0.05	0.50	0.12½
	19-21	7.00	0.04	0.50	0.12½
	17-19	5.05	0.03	0.50	0.12½
Unskilled Labor	over 25	9.30	0.06	0.40	0.10
	21-25	8.15	0.05	0.40	0.10
	19-21	6.80	0.04	0.40	0.10
	17-19	4.75	0.03	0.40	0.10

Machinery

HAS THERE BEEN A DECLINE IN FOREIGN TRADE?

No figures are needed to show that there has been a decided decline in the foreign trade of machine tools and metal-working machinery during 1921, and it is generally believed that there has also been a decline in the foreign trade of the United States as a whole, which is thought by many to be one of the causes of the present industrial depression. The Federal Reserve Bank of Boston calls attention to the fact that for several months statements have appeared in the newspapers showing that the exports of the United States were several hundred million dollars less a month than during the corresponding month a year ago, a decline amounting to as much as 50 per cent or more. In order to ascertain whether our foreign trade actually is declining, when considered from the standpoint of volume rather than of value, an investigation was made which shows that the total volume of our exports is now actually higher than it was during the first months of 1920, although its value in dollars is considerably less. Therefore, instead of our exports actually falling off, they are really increasing, and furthermore the exports measured by physical volume have been materially higher in 1919, 1920, and 1921 than they were in 1913.

There are two factors which tend to confuse the foreign trade situation. The first is that there is a tremendous tonnage of shipping idle at the present time in our harbors. The other is that foreign exchange operates against most countries and in favor of the United States. As for the idle ships, notwithstanding the great amount of tonnage involved, the Government reports that the tonnage of vessels engaged in foreign commerce entering and leaving our ports at the present time is considerably more than a quarter greater than the average during the pre-war years of 1911 to 1913. This corresponds closely with the increase in the physical volume of both exports and imports as described in the foregoing. The reason for so many idle ships is thus seen to be not a decline in the amount of shipping actually engaged in commerce, but the fact that new tonnage came into existence during the war faster than it was destroyed; furthermore, there has been considerable construction since the armistice. There is, in fact, a greater tonnage of merchant shipping afloat today than ever before.

Increase in Volume of Exports

The physical volume of our exports to Germany during the year ended June 30, 1921, aggregated 66.8 per cent (two-thirds) of their pre-war total, and the tendency during the last few months has been for it to increase. An analysis of the volume of exports of specific commodities shows that Germany took 40 per cent as much cotton, 50 per cent as much copper and considerably more foodstuffs during the fiscal year of 1921 than in the corresponding year of 1913.

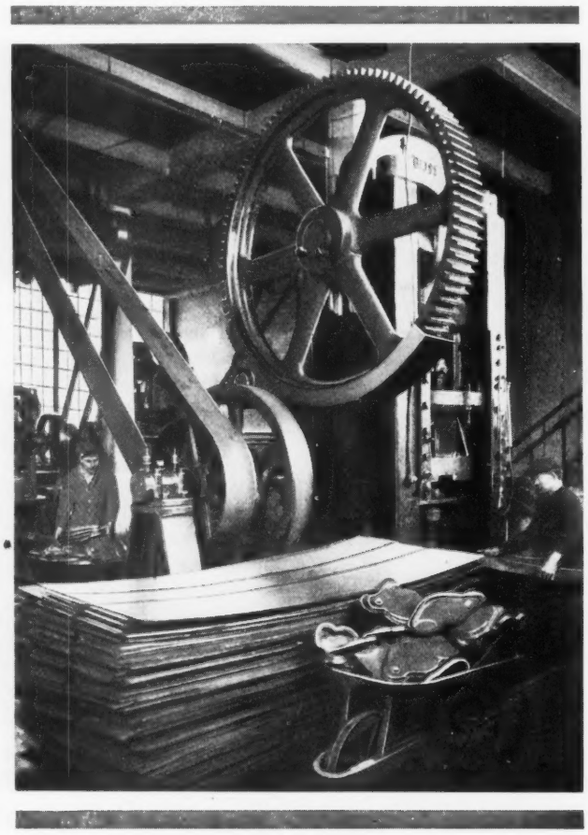
The United States' trade with Soviet Russia is much greater at the present time than is generally realized. The United States Department of Commerce has issued a statement based on official Soviet papers which shows that the United States supplies 16 per cent of Soviet Russia's imports, only Great Britain and Germany furnishing a larger proportion. Shoes, especially men's, represented more than half of the goods we shipped, the bulk of the remainder consisting of leather, white flour, binder twine, and agricultural machinery.

Our foreign trade situation is not discouraging when viewed broadly. Certain aspects of it, such as the decline in the exports of finished goods, have undoubtedly aggravated the depression in the manufacturing industries. The productive capacity of the latter was expanded more rapidly during the war than the normal growth of this country warranted. On the other hand, the increase in the exports of raw materials has had a tendency to relieve the stress somewhat in other fields.

Utility of Single-action Straight-sided Presses

By N. T. THURSTON, The Acklin Stamping Co., Toledo, Ohio

THE simplest and probably the oldest form of power press is the single-action straight-sided type which, because of its simplicity and general usefulness, is widely employed. This press is made in a greater number of sizes than any other one type. The heights range from 51 inches to around 18 feet, while the weights vary from 1400 pounds to 150 tons. The smaller sizes are of the single-crank type, and are driven directly from the flywheel. The intermediate sizes are also of the single-crank type, but are geared. Such a press is shown in the illustrations. The largest presses have two cranks and are double-geared.



Double-crank presses are used in work requiring considerable pressure, but this is not the only reason for employing the double-crank construction. The need of a large die space is often a more important factor than the power which these presses are able to exert. For example, in forming automobile fenders, hoods, bodies, and pans, a press of great strength is unnecessary, but a space large enough to accommodate the dies for forming these parts is an essential requirement. The space necessary for the die used in forming the engine pan of a popular automobile is 42 by 42 inches. A double-crank single-geared press is used for this work, but the press is required to use only one-fifth of its normal working power.

Construction of the Press Frame

The frame of heavy-duty presses is subjected to considerable strain, and this is compensated for by various constructions. In one design the frame sides are cast comparatively light and hollow, and are held to the bed by long tie-rods that extend to the top of the frame. These rods are threaded at both ends, and are provided with nuts that are screwed up while the rods are red hot at several points along their length. The shrinking of the rods, in cooling, puts the frame under a compressive stress greater than any opposing strain to which the press is subjected while in operation, and so keeps the frame rigid.

The heading illustration shows a press of the tie-rod construction being used in the production of gear covers. The blank is cut and the cover formed in one operation. The press is kept running continuously, and every stroke is effective except those lost while a fresh piece of stock is being put in place. The production on work of this kind is limited mainly by the speed of the press, and in the case illustrated is about 230 pieces per hour.

Classes of Work Done on Single-action Straight-sided Presses

Single-action straight-sided presses can be employed for blanking, piercing, wiring, flanging, lettering, embossing, forming, and drawing operations. Many of the difficult forming and drawing operations usually accomplished on double-action presses can be done on the single-action type if a series of proper reductions is made on the part by the use of dies having the proper radii, and when single-action presses are equipped with rubber or spring pressure attachments, they can perform the same sort of drawing work that is done on toggle or double-action presses. Also, when single-action presses are provided with some kind of air pressure attachments, drawing operations on stock which varies in thickness can be performed more successfully than on toggle presses.

This is true because the air attachment gives a constant and uniform pressure on the blank-holder regardless of the variation in the thickness of the metal being drawn, while a blank-holder actuated by means of toggles always assumes the same position on the downward stroke of the press ram and so variations in the thickness of the stock are not compensated for. The result is a pressure on the stock that is either too light or too heavy. An excellent example of the satisfactory manner in which work can be produced on single-action presses equipped with air pressure attachments is the United States Army steel helmet referred to in "Pneumatic Cushions in Metal-drawing Operations," which appeared in April, 1920, MACHINERY. Parts typical of the work handled by single-action straight-sided presses are gear covers, automobile engine pans, fan blades, muffler cones, and universal joint housings.

Feeding the Stock

The front-to-back opening in straight-sided presses permits long strips or rolls of stock to be fed through the die. While this method of feeding has advantages, it is not as convenient as the cross-feed possible with inclinable presses. With the latter method the operator can remain seated directly in front of the press, while with the front-to-back feeding method the operator must sit or stand at one side of the press center, as will be seen by again referring to the heading illustration. The ideal job for a single-action straight-sided press is work which can be performed with a die that allows the stamping to fall through the die and bolster and into a pan beneath the machine.

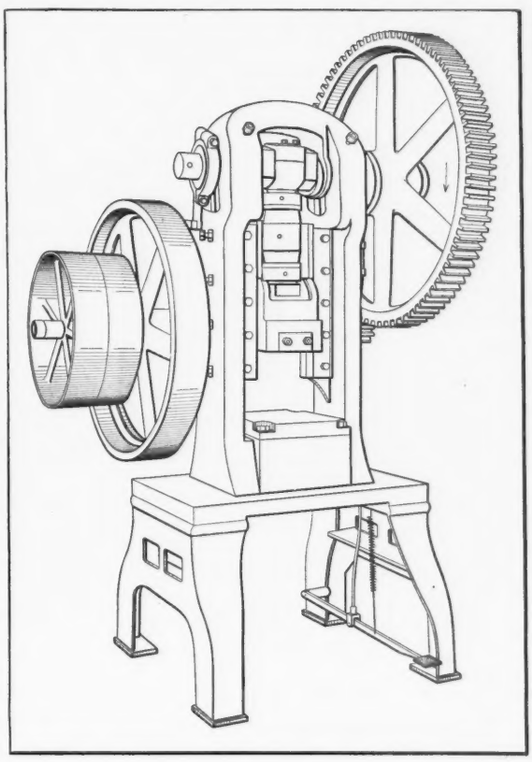
Push-through operations enable the greatest production on this type of press, and a good operator protected by safety devices can keep the press running continuously on such work. On the large presses, which are double-geared and therefore slow-running, there is enough time to remove the work from the die and insert a fresh piece while the press is in motion. This is the procedure with the machine

shown in the heading illustration, and it is not as risky as it may seem, because the large presses are equipped with friction clutches which enable the operator to stop the ram at any point along its stroke. Thus if a part is placed crosswise or in any other incorrect position on the die, the press can be stopped before the punch reaches the work.

* * *

PRODUCTION OF LIQUID AIR

The production of liquid air by the Hampson process in the plant installed at the Bureau of Standards is described in Technical News Bulletin No. 55 of the bureau. A four-stage steam-driven compressor delivers air at room temperature and under a pressure of approximately 3000 pounds per square inch; this air then passes through an oil and water trap and a purifying train containing reagents that remove the carbon dioxide and water vapor. The air thus compressed and purified is then delivered to the liquefier, and after it has passed through a coil of copper tubing, it is allowed to expand freely to approximately atmospheric pressure. When this drop in pressure takes place, there is a corresponding drop in the temperature of the air. The expanded air before leaving the liquefier circulates around the copper coil that contains the compressed air, thus cooling it, so that in continuous operation a cycle of progressive cooling is maintained until the temperature ultimately reaches the liquefying point. The liquefier is constructed so that the air that is condensed is delivered into a receiving vessel. The gaseous air exhausted from the liquefier is returned to the intake of the compressor for succeeding cycles because it has been purified, and when used repeatedly will be found to be much less exhausting on the purifying reagents that are employed to remove the carbon dioxide and water vapor.



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STANDARDIZATION OF SUPPLIES FOR WAR DEPARTMENT

The supply branches of the Army have been directed by the Secretary of War to utilize, in connection with their specifications, the standards that have been or may be adopted by the American Engineering Standards Committee. This is part of the general policy of the War Department to coordinate its whole supply system with the best commercial practice, and to support a national program of engineering and industrial standardization, which represents the difference between being able to get the needed quantities of uniform articles of tested usability, and of being restricted by many varieties, the usable quantities of which are always insufficient. The importance of standardization of war supplies cannot be exaggerated. In times of war the united effort of an entire nation and the combined employment of all its principal industries are necessary. It is possible to harmonize the use of thousands of articles to a common end only by the adoption of a far-reaching and effective program of standardization. Both the business and military interests of the War Department can be greatly assisted by adopting the policy of standardizing supplies.

BIOGRAPHY OF GEORGE WESTINGHOUSE

The life of George Westinghouse is an inspiring record of achievement, and those interested in following the careers of outstanding men in the engineering profession will welcome the new biography of this remarkable man which has been brought out by the American Society of Mechanical Engineers. This book is one of a series of biographies of the great men in mechanical engineering, and is published by Charles Scribner's Sons of New York (price $2.50). It should be an inspiration for those in the engineering field and for business men outside of this field to read the fascinating record written by Henry G. Prout of the part the engineer plays in modern civilization as disclosed in the life of George Westinghouse.

The story is of the rise of a man from a modest early environment to the leadership of many great industrial enterprises, and a position of acknowledged pre-eminence among the engineers of the world. The activities of George Westinghouse were many and varied. He dealt with organization, financial, and executive affairs, commercial affairs and the engineering details of half a dozen companies in two hemispheres. His inventions, particularly that of the air brake, and his development of the use of the alternating current, have had an important influence on civilization. The first chapter of the book contains a brief review of his life, and each of the succeeding chapters is devoted to a distinct phase of his activities.

The book is written in a readable style, and even those outside of the engineering profession will undoubtedly be interested in reading the story of the invention of the air brake and the friction draft gear and their effect in advancing the art of transportation. George Westinghouse's electrical activities, his contributions to the development of signalling and interlocking systems, and his work in extending the use of natural gas, all form part of the interesting narrative. The last chapters of the book treating of his personality and relations to men show that he was as unusual in character and charm as he was in mechanical attainments.

* * *

ASSOCIATED TECHNICAL SOCIETIES OF DETROIT

The engineers, architects, chemists, and other technical men of Detroit have realized for some time the need of one central association to represent their combined interests, and as a result an organization has been formed, known as the Associated Technical Societies of Detroit, which includes twelve societies in the fields mentioned. The association will take an active interest in all matters relating to engineering, architectural, and technical subjects, will assist in furnishing definite and accurate information to the public, and will render assistance and advice to city and state officials when required. A temporary council was organized last June, and on December 13 a permanent council met and elected the following officers for 1922: Chairman, P. W. Keating; vice-chairman, A. A. Meyer; and secretary-treasurer, Walter R. Meier.

FEBRUARY, 1922 **MACHINERY** VOL. 28 NO. 6

PUBLISHED MONTHLY BY THE INDUSTRIAL PRESS, 140-148 LAFAYETTE ST., NEW YORK

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MACHINE TOOL PRICES

In December MACHINERY a careful analysis was given of various factors in the cost of machine tools for the purpose of showing why a return to 1914 prices, or even an approximation thereto, apparently expected by some purchasing agents, is impracticable under present conditions. One or two cost items which have been considerably reduced are frequently used as a basis for requiring a reduction of the selling price; but the aggregate cost has not been reduced in a like proportion.

Machinists' wages at present are very nearly double the rates in 1914. Skilled foundry workers who were paid $3.50 a day in 1914 in one of the large machine tool centers are now, after a reduction in wages of 20 per cent, paid $7 a day. Although pig iron has been reduced to within 25 or 30 per cent of the 1914 price at the blast furnace, it still costs about 50 per cent more than in 1914 in the machine tool centers, owing to increased freight rates. Bituminous coal has been reduced in price, but when a carload of coal costing $70 at the mine becomes worth $178 delivered on the siding in Cincinnati, the manufacturer finds that it costs him about 100 per cent more than in 1914. Crating lumber, of which large quantities are used by machine tool builders, cost $17.50 a thousand feet in 1915, and now costs $30, which is probably the bottom price for some years, as lumber already has been materially reduced from the peak price and the supply is decreasing.

The general result of complaints about high prices affects public opinion in the machinery industry unfavorably and often works an injustice to manufacturers, when the facts mentioned are not taken into account. Those who expect to buy machine tools as cheaply as before the war and are deferring necessary purchases until prices approach the pre-war level will wait a long time before buying new machinery, and in the meantime will lose the saving represented by the use of new and efficient machine shop equipment.

* * *

A NEW MACHINE TOOL MARKET

The increasing use of machinery and mechanical appliances everywhere, upon the farms as well as in industrial centers, is opening up an entirely new field for men who have the training, a small capital, and the inclination to go into the repair shop business. The old blacksmith shop is gradually passing out of existence, but its place is being taken by small modern repair shops, equipped with good machine tools, and there will soon be work for such shops all over the country.

These shops are required to keep in repair automobiles, tractors, agricultural machinery and other mechanical devices in general use. To function efficiently they should be equipped with at least lathes, drilling machines, shapers and cylinder grinding machines; and as these repair shops grow in size and importance, some of them will add other tools.

The machine tools required for this class of shop differ from those needed in a manufacturing plant. Production is of secondary importance, but the machines must be comparatively inexpensive, easily adapted to a wide variety of work and of quite large range, even though not powerful. Here is a field that has not yet been fully covered by machine tool builders—a market which will gradually expand.

NOW IS THE TIME FOR REPAIRS

Many manufacturers see that now is the best time for thoroughly overhauling their shop equipment and eliminating obsolete and worn out tools and equipment. Old machines are being sold either for junk or to the second-hand dealers, and although some manufacturers may not yet be financially able to replace them, it is evident that new equipment must soon be installed to keep pace with competition. The amount of old machinery that has been scrapped indicates that buying will be active when business revives, because there are many empty spaces in factories left for the installation of new machine tools of higher productive capacity.

In addition to the elimination of old machinery in many plants, the entire equipment is being overhauled and "remade." This is especially true of the machine tool building plants; but judging by the orders for repair parts received by machine tool builders, this overhauling is being carried on in many other shops throughout the country. The forward-looking manufacturer knows that the depression is nearing its end and shows his wisdom by using the present time to re-condition his equipment. Not only will his money go further now than when normalcy returns, but deliveries are prompt, the labor costs less and the productive work of the factory is not interfered with.

Manufacturers who defer this work until good business is actually upon them will lose time, money and opportunity.

* * *

EVER-INCREASING FIELD FOR MACHINE TOOLS

The universal use of machinery in the industries at the present time apparently does not leave much opportunity for designing improved machinery to replace hand labor—at least not in the metal-working field. Yet six machines were installed recently in a large plant in one of our greatest industrial cities that, although operated by but two men, replaced seventeen skilled mechanics. The cost of the entire machine equipment was $3600, and it is not difficult to calculate how long it will take to pay for these machines simply by the saving in the wages of fifteen skilled men. The machines are fed by magazine attachments and turn out a more uniform product than has been possible by hand.

There is a lesson to be learned from the result of this installation. The machines in this case cost $600 each, but if they had cost $1000 or $2000 it still would have been economical to buy them to replace such a large number of skilled men drawing high wages. In other words, they were not worth buying only because they were low priced; but because of their productive capacity.

At the present time, when so many men are out of employment, it may seem heartless to replace skilled labor by machinery, but the reduced selling price of the product in question, which is fixed by competition and yielded no profit by the old method, would have made it necessary for several of the plants to close down had not a cheaper production method been devised. Ultimately, no one would have gained by continuing the hand labor at a loss.

The results of this installation show that great opportunities still wait for saving in production costs by the use of improved machinery, and that we are still far from the limit of productive capacity.

The Machine Tool Market in Asia

By C. F. MEYER, Landis Machine Co., Waynesboro, Pa.

The author of this article has recently completed a trip around the world for the purpose of studying the machine tool markets in India, Java, China, Japan, and Australia. He brings back with him much valuable information, some of which is made available to American manufacturers in this article. The definite information given by Mr. Meyer should prove of great value to manufacturers who are interested in developing their export trade in the Far Eastern countries.

THE market for American machine tools in Asia has had a phenomenal growth since prewar days. Prior to 1914 the majority of the Far Eastern countries were satisfied with their antiquated methods of manufacturing, but things have changed now. The mysterious forces connected with the war have aroused the Far East from her slumbers. The Orient, during 1913, absorbed approximately $200,000 worth of American machine tools. The sales increased yearly until 1919, when the high peak was reached. During that year the sales amounted to nearly $9,000,000. The preliminary returns for 1921 indicate that the exports of American machine tools to the Orient will reach $6,000,000.

This is certainly a very creditable showing, considering the current exchange rates and the price reductions that have been made during the last six or eight months. The Chinese and Japanese rates of exchange have been normal for practically the best part of the year. The present rates in the Dutch East Indies and British India are still unfavorable, but not to the extent that they were in 1919, when the peak was reached. An analysis will show that the value of the sales for 1921 is thirty times the value for 1913. Considering the recent price reductions and the improvement in the exchange, it is safe to assume that the total volume of sales to the Far Eastern countries for 1921 is not much, if any, below the volume for 1919.

Probable Future Demand

The Orient is awake industrially. Japan has for a long time appreciated up-to-date machine tools, but there is still room for improvement. It is said that India learned to use machine tools during the war when she took up her share of the manufacture of munitions. China needs equipment badly, but at present is short of funds. Java may be considered a limited market, but there are good prospects for doing business with the government railways and shipyards and with the sugar mills and mines for certain classes of machine tools.

Labor is also undergoing a change. The workman is demanding a greater return for his labor. To meet this the manufacturer must have greater production. Naturally he turns to production machinery to solve his problem. The demand of the Oriental workman for a higher standard of living has already had its effect on the machine tool business.

In India the industrial development has been much more rapid than in the other Oriental countries. Prior to the World War, India was regarded as a repair shop for reconditioning ships and repairing rolling stock. Her unlimited supplies of raw materials were shipped to England and converted into finished products. Now things have changed. The policy today is to establish industries throughout the land. In the vicinity of Calcutta, jute mills line both banks of the Hugli, the principal delta mouth of the Ganges River. These mills are equipped to spin the raw material, weave the burlap, and manufacture gunny sacks. Practically all the burlap and gunny sacks used in the entire world come from this district. These jute mills have up-to-date machine shops for plant maintenance, and several are equipped to manufacture their own spinning machines and looms.

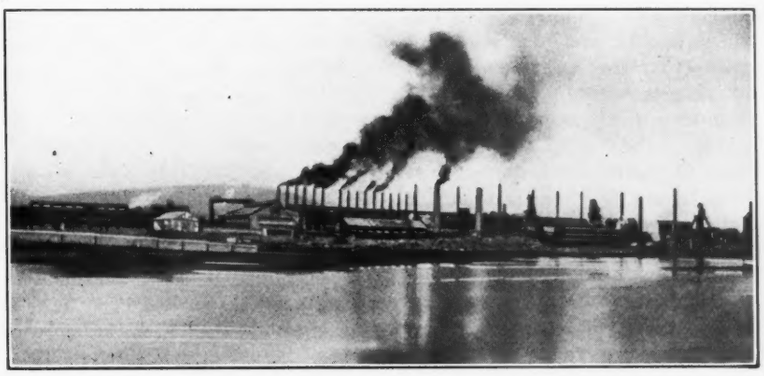


Fig. 1. The Tata Iron & Steel Works at Tatanaga, India

At Tatanaga, close to the coal and iron mines, stands the Tata Iron & Steel Works. This plant covers a very large area and compares favorably with the best steel mills in the Pittsburg district. It has both Bessemer and open-hearth furnaces and a rolling mill equipped to roll rails and structural steel. It was founded by J. N. Tata, a Parsee, but is now managed by American and British engineers.

Other industries are springing up on every hand. It is impossible to foretell the outcome, but it is safe to say that India with her unlimited supply of natural resources is destined to become one of the greatest manufacturing countries of the world. India's one handicap is her railroads, which have not kept pace with her industrial development. Her greatest need today is rolling stock and motive power to transport the raw materials and coal from the mines to the industrial centers.

How to Secure Far Eastern Trade

The American manufacturer seeking Far Eastern trade should first make a careful study of the various markets. He should proceed with caution. He should not act hastily, as did a certain wall paper house which sent its representative into the Far East for business. Had it taken the trouble to investigate, it could have easily learned that wall paper, due to climatic conditions, will not stick to the walls in British India, Burma, the Straits Settlements, the Dutch East Indies, and some parts of China. The representative encircled the globe and had a wonderful time, but he secured no business.

Practically all the American machinery sold in the Far East is sold through machinery dealers. This is the best and only way to handle the proposition. The largest and most desirable machinery dealers in the Orient have offices in New York City where the preliminary arrangements can be made. These include American, British, Dutch, Chinese, and Japanese houses. The manufacturer should get in touch with the New York offices of several of the machinery dealers in each country where there is a market for his product. He should obtain particulars re-

garding their organizations and at the same time find out whether or not they are in a position to handle his line without conflicting with a competitive line. The manufacturer is then ready to weigh the merits of the several dealers and make his choice for each country.

As soon as the connections have been made, the manufacturer should see that each dealer is supplied with descriptive literature, price lists, and advertising matter. No attempt should be made to print these in the native language, as English is read by almost everyone holding an official position. In fact, it is preferred by the majority of the Orientals whose languages are void of technical terms. The shipment of printed matter should be followed by a shipment of machines and accessories for stock.

The Manufacturer's Representative

The next move is to send a representative, preferably an engineer, into the new territory to get the agents started on the right track. Great care should be exercised in picking the right man. He should have a pleasing personality and should understand the art of making friends. Above all he should know his line. Do not consider a man who will boast of his own country and belittle the country he is visiting. This will react against all American manufacturers and consequently will injure America's foreign trade.

Travel in the Far East is expensive, and much of the traveler's time is unproductive. A year's trip with an itinerary including British India, Burma, the Straits Settlements, the Dutch East Indies, China, and Japan will make it necessary for the traveler to spend from three to four months on the seas. He can handle two or three lines, either through the same or different agents, almost as easily as he can look after one. Thus several manufacturers can, by pooling the expense, secure their share of the Far Eastern business at a comparatively low cost.

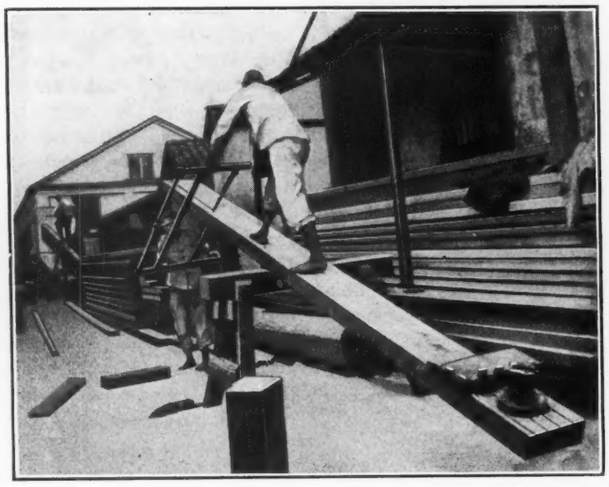


Fig. 2. Chinese Woodcutters sawing Lumber at the Government Arsenal near Shanghai, China

Methods of Selling

The traveler should remain in each country long enough to enable him to call on the most important prospects. He should also take time to instruct the salesmen and arouse in them an enthusiasm for his line. This is very important, as the Oriental salesman will not push the sale of a machine tool he does not know well. He prefers to remain silent rather than run the risk of "losing face."

The majority of the engineers met in British India are British. In the Dutch East Indies the engineers are Dutch. The Dutchman is a born linguist and generally speaks four or five languages. The Chinese and Japanese engineers usually understand some English even though they are unable to speak it. Besides, the traveler is always accompanied by either a foreign or native salesman who is ready at all times to act as his interpreter.

In planning a business trip to the Orient, it is very necessary to know that all the railways, the telegraphs and the telephones in British India, the Dutch East Indies, Japan, and some of the railways of China are under government control. All the government plants in these countries do their buying during the months of December, January, February, and March. Each year they make application to their respective governments for sufficient funds to take care of the coming year's requirements. The appropriations, if granted, are available early in December and must be spent before the last day of March. These shops, together with the government dockyards and arsenals, make up a large portion of the industries of the Orient, and serious consideration must be given to their business methods.

The most extraordinary phase of the government buying system is the requirement that no order can be placed with an agent unless the goods are in the country or en route. The law requires that delivery must be made and all invoices paid on or before the last day of March; otherwise, delivery is refused and the money returned to the government.

The wide-awake dealer keeps in touch with the engineers of the government plants with the view of getting a line on their requirements. He then orders a sufficient stock far enough ahead of time to insure delivery during the buying season.

The Itinerary for a Far Eastern Business Trip

To go back to the traveler and his itinerary, the ideal arrangement would be for him to arrive at his destination a little before the buying begins and remain until the season closes. This fits in very nicely with the cool weather, but unfortunately the buying seasons are the same in a number of countries.

The monsoon or rainy period in India begins about the first week in July and continues until the end of September. During this time the heat is almost unbearable. The best plan is to proceed to the Orient via England and Suez and spend the months of November, December, January, and February in India. Allowing a month to travel from Calcutta to Batavia, the traveler will be in Java by the first of April. April and May are very hot and rainy months in Java. This, however, cannot be avoided. A side trip of several months to Australia and New Zealand will give the traveler a taste of cool weather, the seasons in the southern hemisphere being just opposite to our own. He can then work north by way of the Philippine Islands to either China or Japan, arriving there just prior to the opening of the buying season.

The American engineer is well received in all quarters of the Orient. The visitor is always welcome, especially if he is traveling in an out-of-the-way district where news of the outside world is scarce. He is frequently entertained in a most hospitable manner at the home of the engineer on whom he is calling. During one of my visits to a large steel works in British India I was invited to spend a day and a night with a high official of the company. On another occasion, when I was calling on one of the railway shops in the same country, I was met at the railway station by the chief engineer who had come up from the shops some three miles distant on a push-car. It was a new and strange experience for me to go spinning along the rails on a contraption similar to a hand car, which was pushed along by two half-naked Hindus, each running on top of the rails.

Types of Machine Tools Used in the Orient

The average Oriental workman is lazy and naturally opposed to work. Furthermore, he is afraid of a machine tool and looks upon some of the more complicated types as objects possessed of evil spirits. This is particularly true of the Hindu workmen and has a very important bearing on the types of machine tools used in British India. The Hindu

operator always runs his machine at the slowest speed possible. He seems to fear that it will fly to pieces and cause him bodily injury if he speeds it up.

On one occasion, when I was being shown through a large railway shop in British India, my attention was directed to a Landis threading machine. At a glance I noted that the Hindu operator was threading ½-inch bolts at the speed intended for 1¾-inch and 2-inch sizes. I spoke to the engineer who accompanied me regarding this. He was on the job in a second; he grabbed the Hindu by the back of the neck and poked his nose against the high-speed pulley of the cone, remarking at the same time in Hindustanie that for the hundredth time he wanted it understood that the machine must be speeded up. The poor Hindu took this gentle hint and stepped the belt up to the proper speed. My sympathy was with him until, some fifteen minutes later when I passed the same machine on my way out, I observed that he had put the belt back on the slow-speed pulley. I had no desire to see murder committed, so I made no mention of the fact to my friend the engineer.

It would be absurd for American manufacturers to ship multiple-spindle machines into British India, because neither the Hindu nor the Mohammedan will operate more than one spindle of a multiple-spindle machine. This applies to drills, tappers, and threading machines. In British India a machine of this type would require an operator for each spindle; this is a bad condition from the production standpoint. The operators either converse or fight and the output of each suffers. If but one operator is assigned to a multiple-spindle machine, he will work one spindle only and let the remainder run idle. I saw evidence of this in many of the shops which I visited, particularly among operators of multiple-spindle drilling and tapping machines.

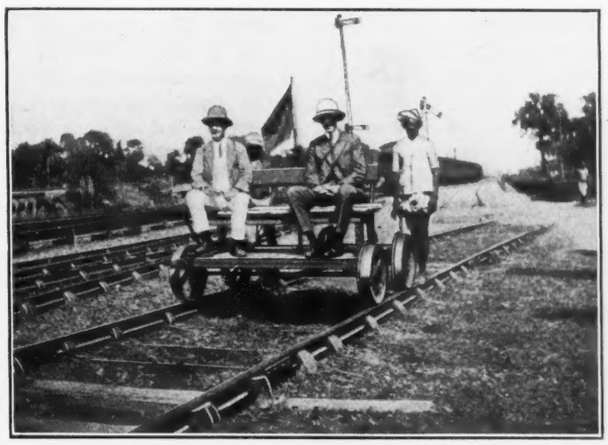


Fig. 3. The Author and the Chief Engineer of the B & N Railway enroute to the Shops of the B & N Railway near Calcutta, India

The Effect of Religious Beliefs in India

Two very important items which should be given consideration are the recommendations for belting and cutting lubricant. The cow is sacred to the Hindu and consequently he is opposed to the use of leather belting for driving machinery. On the other hand, the pig is sacred to the Mohammedan and he will not use a cutting lubricant having animal lard oil for a base.

During the war, when the engineering firms in British India introduced automatic and semi-automatic machines for the manufacture of munitions, they found themselves face to face with a peculiar condition. They picked their best native mechanics for these machines. These operators had hardly started when they quit work in a body. They claimed that machinery capable of doing the work that these machines would do must be possessed of evil spirits and flatly refused to operate them. The engineers in charge were then forced to go out and round up natives of the coolie class, who were too ignorant to bother about evil spirits, and train them for this work. These men soon learned that the movement of certain levers was necessary to perform the several operations in the proper sequence. They became expert operators, but without any knowledge of real action of the machinery.

The Prospective Market in China

The Chinese market seems to prefer cheap machinery. This may be attributed to several causes, but one of the most important is that Chinese labor is opposed to labor-saving machinery. They cannot see that they will be benefited by increased earnings and that the introduction of labor-saving machinery into their country will stimulate manufacturing and create work enough for them all. They take the stand that labor-saving machinery requires fewer men and would therefore cause large numbers of their class to be thrown out of employment.

Another obstacle to the introduction of up-to-date machinery into China is the cheapness of labor. I was told that the average mechanic receives in the neighborhood of $12.50 a month and that common labor is paid as low as $3 a month. The apprentice works for a period of three years with no pay except his daily ration of rice. A certain American company attempted to introduce a line of tractors into China by lending them to the farmers in different districts. A demonstrator was sent with each machine. The results obtained by the demonstrators showed the operating cost of the tractor to be approximately $25 a month. This figure seemed low enough to the firm's representative to insure a good business, but the farmers both surprised and disappointed him by claiming they could hire eight farm hands to do the work for the same amount of money.

Still another obstacle to the use of machine tools by the Chinese is the time-honored custom of using their hands. They apparently prefer to stick to the antiquated practice of making everything by hand. During a visit to a large engineering firm in the city of Tientsin, I was invited by the manager to inspect the works. I found the machine shop well equipped with first-class machinery of American and British make. On entering the pattern shop, I was impressed with the absence of woodworking machinery. I made a careful inspection and could find nothing that resembled a machine, not even a wood turning lathe. In answer to my inquiry regarding this, I was told by the manager that he had made several attempts to install suitable machinery, but that his Chinese pattern-makers preferred to make the patterns by hand. I was shown patterns of an eight-ton flywheel and a one-cylinder gas engine frame, together with some of the most intricate patterns I have ever seen, all fashioned by hand. It was difficult for me to believe that the cylindrical portions of these patterns had not been turned in a lathe.

In the foundry I found the workmen pouring a 3500-pound casting. There was no tackle for handling the huge ladle. Aside from the head molder, I counted twenty-four coolies assisting in carrying the molten metal from the cupola to the mold. I was told that the head molder would receive the equivalent of $45 for the job and that he would pay his coolie assistants at the rate of 25 cents per day.

I was told that there are only a few sawmills in the whole of China. This means that practically all the lumber used in the country is cut by hand. If one wishes to build a home or a factory, it is necessary to have the rough logs hauled to the site and woodcutters engaged to come and saw them up into studding, joists, rafters, flooring, etc. These men are experts who will do the work just as well as it can be done at the sawmill; and their wages compare favorably with the prices charged by the sawmill.

Until recently, a great deal of the manufacturing in China was done in the homes of the workmen. Even today there are still several hundred machine shops in the city of Shanghai occupying either the front or rear rooms of dwelling houses. These shops, as a rule, operate on a very small scale. The equipment consists of a lathe, a drilling machine

and, in a very few instances, a shaper. These machines are principally of Chinese make and are very crude. In one of these shops which I visited, I found them using the lathe to saw off stock. The saw was mounted on the live spindle of the machine and the piece of stock was gripped in the cross-slide. In another place, they were using a lathe to mill a slot in a piece of steel.

Creating a Demand for Machine Tools in China

Before we can look upon China as a good market for machine tools it will be necessary to create a demand. This can be accomplished by educating the masses to use machinery. A well-known oil company created a demand for kerosene in China in a most satisfactory manner. The company knew that the Chinese are very fond of artificial light, but to get them to discard their antiquated lamps which would not burn kerosene was the problem to be solved. A large quantity of tin lamps painted blue (the favorite color of the Chinese) were made. The lamps were filled with kerosene and handed out to the Chinese population in certain districts. These lamps were far superior to the Chinese lamps. John Chinaman was very much pleased with his new possession, and when the oil which was furnished with the lamp was burned up, he immediately purchased more.

The market for up-to-date machine tools might be created in several ways. The first thing to do is to make the Chinese acquainted with the machine and then prove to them that it will turn out a superior quality of work at a lower cost than the cheap and crude equipment with which they are familiar. This can be accomplished by placing machines in the engineering colleges and trade schools in China, and educating the coming engineers and mechanics. This does not mean that the machines should be presented to these institutions. The plan adopted by a large number of American manufacturers is to make their prices fit the pocketbooks of the colleges and schools. Some have even gone so far as to sell their products to these institutions at half price. They hope by this means to induce a portion of the graduates of the engineering and trade institutions to affiliate themselves with the industries of China and replace the present crude equipment with up-to-date machinery.

Educating the Chinese Student in America to Use our Machine Tools

The demand for American machine tools can be helped along in still another way. Each year the Chinese Government picks by competitive examination one hundred Chinese boys and sends them to this country to be educated in our engineering colleges and universities. These students return to China after graduation and are given important positions with the railways and other branches of the government service. They become more or less familiar with American machine tools during their stay here, but the manufacturer can help his particular machine along either by arranging lectures before the foreign student bodies in the engineering colleges, or by extending invitations to these students to visit and inspect his plant.

I am told that it is impossible for a Chinese graduate of an American engineering college to obtain practical training in our factories, except without pay. This is due to our immigration laws and also to the ruling of the labor unions. The result is that the young Chinese engineers are going to England and France for their practical training. Thus they unconsciously develop a leaning toward British and French machine tools. I do not wish to convey that China is totally ignorant of high-class machine tools. On the contrary, there are some fine plants in China, and credit is due the machinery agents who are responsible for what has been done.

Japan is much further advanced than the rest of the Oriental countries and is a well developed market for all classes of machine tools. The Japanese, however, have begun the manufacture of machine tools, and have thus created additional competition not only in their own country, but throughout the whole of the Far East.

INDUSTRIAL CONDITIONS IN FRANCE

By MACHINERY'S Special Correspondent

Paris, January 12

Business conditions in the machine tool field showed a decided improvement during the month of December, many new orders having been placed. Inquiries are becoming more and more frequent, and often lead to the placing of orders. The feeling exists that this is not a temporary improvement, but that the condition will continue and that the year 1922 will witness the end of the great business depression which has swept over the metal-working industries. So far the plants in the vicinity of Lyons have benefited the most by the improved conditions. The machine tool activities are in general the result of furthering the development of the water power resources, increased manufacture of locomotives and railroad cars, and overhauling of railway equipment.

Improvements in Associated Industries

Boiler manufacturing and similar establishments are profiting from the renewed activity in the chemical industry, which has created a demand for tanks and large metal containers. The manufacture of boilers, however, is at a complete standstill. Rolling mills and foundries continue to receive orders, and there is quite a good deal of activity in these fields. Copper and brass foundries have also experienced a decided improvement.

In the automobile field the manufacture of the higher priced touring cars and small commercial cars continues to be active. One automobile plant is running the same as in normal times. There is no great demand for large motor trucks, however, and as a consequence one of the principal truck manufacturers had to close down on January 1. The bolt-manufacturing and wire-drawing fields continue quiet.

Present Prices of Machine Tools

American-built machine tools are still in little demand in France on account of the exchange rates. The prices of a number of machine tools built by French manufacturers are:

Lathes—Gap bed type, 15-inch swing, 40 inches between centers, with all accessories, 6200 francs (about $500, present exchange); another lathe of the same type and swing as the foregoing, but with a distance of 60 inches between centers, 6500 francs (about $530); engine lathe, 14-inch swing, 36 inches between centers and weight about 2000 pounds, 8000 francs (about $650).

Crank Shapers—Maximum stroke of ram 16 inches, horizontal traverse of table 22 inches, dimensions of table 18¾ by 12 inches, and weight about 2650 pounds, 9350 francs (about $760); maximum stroke of ram 24 inches, dimensions of table 25 by 16 inches, and weight about 4700 pounds, 13,600 francs (about $1100).

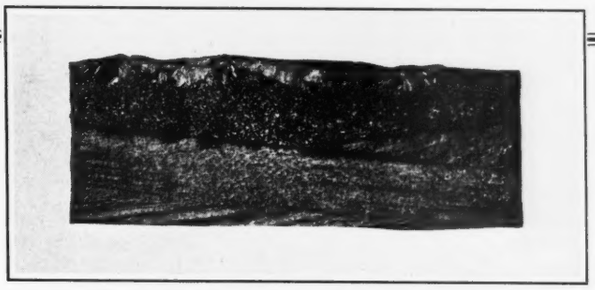
Planers—Width between housings 24 inches, stroke 5 feet and weight 6600 pounds, 17,150 francs (about $1400); another machine of the same width between housings and the same stroke, weighing 5500 pounds, 13,500 francs ($1100).

Drilling Machines—Sensitive, capacity for drilling holes up to ⅝ inch in diameter, spindle diameter ¾ inch, vertical movement of spindle 8 inches, and weight 500 pounds, 1500 francs (about $120); upright drilling machine with stationary head, normal drilling capacity of 1½ inches when provided with gear-box, and 1¼ inches without gear-box, diameter of spindle 1½ inches, No. 3 Morse taper socket, and weight about 1100 pounds, with gear-box 3600 francs (about $290), without gear-box, 3150 francs (about $255); radial drilling machine, normal drilling capacity 1¾ inches, diameter of spindle 1½ inches, and weight 4000 pounds, 10,000 francs (about $810).

Milling Machine—Single-pulley drive, longitudinal traverse of table 20 inches, transverse movement 6 inches, vertical movement 14 inches, the longitudinal traverse only being automatic, weight 2000 pounds, 9450 francs ($765).

Arc-welding of Cast Iron

Use and Application of Methods for the Welding of Cast Iron by the Electric Arc



By A. R. ALLARD
Welding Supervisor
Westinghouse Electric and Manufacturing Company
East Pittsburg, Pa.

Fig. 1. Structure of Cast Iron welded by the Carbon Arc Method

THOSE familiar with the merits and limitations of the electric arc welding process for making welds in cast iron recognize the need of a better understanding of the application of the art. It is necessary to understand thoroughly certain fundamental facts concerning the metal and the relation that its ingredients bear to the actual welding process, if satisfactory results are to be obtained. These and other important facts are discussed in the following.

Carbon Arc-welding Process

Carbon arc-welding is probably the oldest and easiest, in point of manipulation, of the arc methods of welding cast iron. It consists of drawing an electric arc between a carbon pencil and the cast-iron part, causing the metal of the casting and the filler rod to become molten at the point of heat application. Cast iron melts at 2300 degrees F. and volatilizes at 3300 degrees F., and becomes fluid under the heat of the arc. This characteristic limits the use of the method to such work as may be welded in a horizontal plane and to metal of sufficient thickness to prevent the intense heat of the arc from melting through. To facilitate the welding operation by this method, a backing of refractory material is often built around the work.

Many metals have a characteristic known as the critical welding heat at which point the metal suddenly changes from the plastic to the fluid state and above which the further application of heat for extended periods causes burning of the metal. Pure iron is more easily welded by the arc than any other metal, and the method becomes more difficult of accomplishment with increasing percentages of carbon until about 2.25 per cent carbon content is reached, which produces cast iron. Cast iron, when held at a red heat for long periods, deteriorates considerably, and if held at high temperatures will disintegrate and become worthless. When the carbon arc method is used, the metal is quickly brought to the molten state at the surface, and the carbon of the metal becomes dissolved in the iron. When the heat of the arc is removed, the cold sections of the casting quickly dissipate the heat from the molten section, thus producing chilled cast iron, the structural formation of which has the appearance shown in Fig. 1. The action is analogous to that which occurs when pouring molten metal into a steel chill. Care must be taken in manipulating the carbon pencil, for if the carbon comes in contact with the surface of the casting it will usually produce a hard spot.

The Steel Metallic Arc Method

Another electric arc method which is quite intensively used for certain applications of cast-iron welding is the metallic arc method. By this process an arc is drawn between the cast iron and a metal electrode of suitable composition, causing the electrode wire to melt and be deposited in the pocket melted in the cast iron by the heat of the arc. Owing to the doubtful nature of the union of the metals obtained by this process it is customary to insert steel studs in the work in order that the filler material may unite with them and aid in anchoring the deposited metal to the cast iron. When this method of welding is used for repairing fractures in containers for steam, liquids, or gases, the seams or edges of the weld may be calked to obtain tight joints. When welding cast iron by this method, using steel wire electrodes, the fusion of the two metals is dependent upon the state in which the carbon exists. It is known that the closer the carbon in the cast iron approaches the graphitic state, the less dependable will be the union of metals, and that the closer it approaches iron carbide the stronger will be the weld. This condition is due to the fact that as carbon approaches the graphitic state there is less continuity of the iron matrix and less cohesion between the iron crystals, due to the laminated structure of graphitic iron.

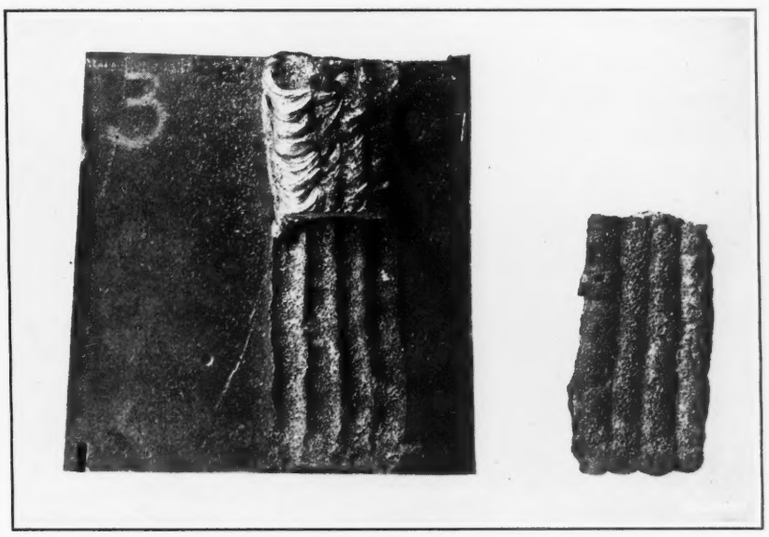


Fig. 2. Appearance of a Cast-iron Weld made by the Metallic Arc Method, showing the Slag Layer at the Line of Fusion

In addition to this characteristic of the process, there is also the likelihood of producing a layer of residue of slag between the two metals at the line of fusion, which will prevent a good union. This condition becomes more serious as the carbon approaches the graphitic state. The layer of residue forms as the steel matrix of the cast

iron becomes molten, and in a molten state is attracted to and unites with the layer of metal already formed and partly solidified. As this movement of metal occurs, due to molecular attraction, most of the graphite in the laminated structure is left without its supporting matrix and settles to the bottom of the depression left by the movement of the metal. This deposit of graphite is a good conductor of electricity, and so concentrates the action of the electric arc, which results in partly oxidizing it and packing it into a layer with the dirt and oxide. The appearance of this accumulated layer of slag is shown in Fig. 2.

The quality of the union can be foretold by the application of the electric arc to a small area of the casting or by a visual examination of a fracture of the casting. This may be seen in Fig. 3, which shows two views of a wedge-shaped casting. The wedge shape enables metal in various physical states to be presented, so that the effect of the application of the carbon arc may be observed. It will be seen that the casting has a fine grain structure at the apex and that the development of the graphitic structure increases with the thickness of the section. The flat deposits in the lower part of the illustration were made with the carbon arc. In cases where the deposited metal spreads over the parent metal to the line of fusion making a smooth appearance, as it does at the left of these deposits, instead of receding at the line of fusion as it does more and more as the graphitic structure increases toward the right, then good fusion can be expected. The string of deposited metal on the upper part of the casting was made by the metallic arc, and in this case also the degree of fusibility and penetration decreases with the graphitic structure.

Factors in Welding Cast Iron

Upon examination of a weld made by the steel metallic arc process, even though good amalgamation of the metals has resulted, numerous small gas pockets are discovered, particularly in the layer adjacent to the casting. These pockets are formed by the gas produced in applying heat to the layer of residue previously mentioned, and by the volatilization of the molten carbon and silicon. There is also a tendency for cast iron to absorb moisture from the air when heated, which upon being gasified may also produce pockets at the joining surfaces.

With this method of welding there exists between the layers of deposited metal and the cast-iron parent metal, a hard carbide area, which cannot be cut except by grinding. This area usually consists of a layer of chilled cast iron

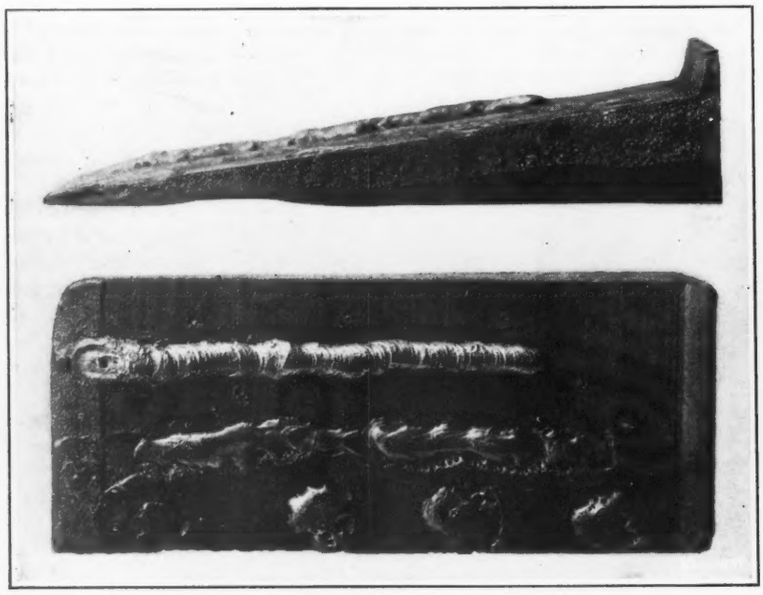


Fig. 3. Effect of a Graphitic Carbon Structure on the Fusibility and Penetration of Metal deposited by the Metallic and Carbon Arcs

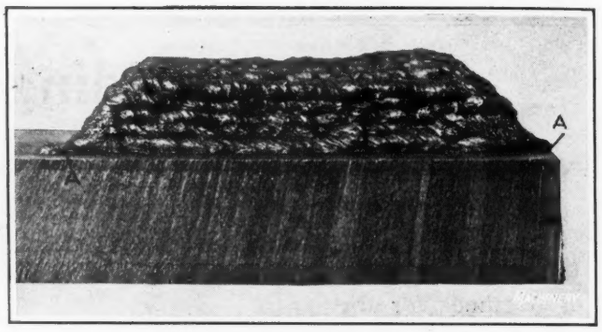


Fig. 4. Steel Filler Material deposited on Cast Iron, showing the Separation of the Deposit from the Original Metal

adjacent to the layer of slag, and located on the cast-iron side of the weld. On the opposite side of the layer of slag and adjacent to it there is formed a layer of chilled high-carbon steel, produced by the alloying of the carbon in the cast iron with the added steel of the wire electrode or filler rod. This layer of high-carbon steel is of varying thickness, depending on the character of the cast iron and the depth of penetration. It will readily be seen that the deeper the cast iron is liquefied by the application of the arc, the greater will be the amount of molten high-carbon steel to unite with the deposited metal.

Difficulty in securing satisfactory welds with the metallic arc is sometimes due to the separation and fracturing of the metals, caused by the shrinkage of the molten metal upon solidification. This trouble is not always due to the difference in coefficient of expansion of the deposited and parent metals, although quite generally attributed to this cause. Contraction and expansion cause more trouble and failure in the welding of cast iron than all other causes combined. Every physical and chemical change in metal is accompanied by internal stresses, and when these exceed the strength of the metal it is not difficult to understand the failures produced by these stresses in a metal that is as rigid and brittle as cast iron. When using a steel filler material in welding cast iron with a metallic arc, the difference in contraction between the two metals usually causes trouble. The strength of the added steel is greater than that of the cast iron, which results in the steel pulling away from the cast iron when contracting, in the manner indicated at *A*, Fig. 4. In some cases, if good fusion has been secured, the cast iron itself will become fractured. The separation usually occurs at the layer of slag, or at the point of contact of the two metals, since this is the line of creepage, and is due to poor fusion. Even though good fusion of the metals has been obtained, separation may occur in the vicinity of this layer of slag and on the cast-iron side of the weld.

The steel metallic arc process of electric welding is the only method adaptable to certain classes of work. Examples of this method are frequently found in castings which permit the use of only a limited amount of heat in performing the weld, and also in jobs which require the operation to be performed by overhead manipulation of the arc. The latter is extremely difficult of accomplishment with any other welding process.

Making a Weld with a Metallic Electric Arc

After cleaning the casting by chipping or sand-blasting the entire surface to which metal will be fused, a square groove is chipped along the line of breakage. The size of this groove depends upon the thickness of the casting, but is usually from ¼ to ½ inch square. The groove is then filled with metal until it is flush with the face of

the casting, and a stud is next located in the casting as close to the crack as practicable. The location of the first stud is determined by the thickness and shape of the casting. The amount of studding necessary depends on the volume of added metal required to give sufficient strength. The studs should be long enough to extend through the first layer of deposited metal, so that good fusion may be obtained between them and the second layer, and they should be set a distance from the edge of the fracture equal to at least twice their diameter.

In welding, the first stud should be surrounded with a sufficient number of rows of deposit to extend to the center of the crack, as shown at *A* in Fig. 5. This procedure will aid in locating the spacing of the remaining studs, which are then set in rows as required to complete the job. Grooves should be placed between the rows of studs, if more than one row is used, and also at the outside edge of the weld area. The preparation as to grooving and studding, as well as the method of depositing the metal, is diagrammatically shown in Fig. 5. All grooves are filled flush with the face of the casting before depositing the first layer around the studs, in the manner followed with the first stud. The outside rows of the pads of adjacent studs are not united at this time except where they merge at their point of tangency. The second layer is deposited around all studs in such a manner as to build up the pads into a cone shape, which will leave a vee to be filled when uniting the pads. As many additional layers as required are then added, in the manner indicated in the illustration. In uniting the pads, those at the line of the break are left until last, in order to permit the greater part of the shrinkage to occur before this union is completed. When more than one layer of deposited metal has been welded around a stud, it is best to follow the circular contour of the pads when filling in between them.

The operation of welding cast iron by the steel metallic arc method should proceed very slowly, each addition of metal being small so that there will be a gradual absorption of the heat by the work. The practice of drilling holes at the end of the fracture is optional, and should not often be required because the casting should never be allowed to get warm enough to expand and extend the break. The use of small wire, low current and straight-line welding, without weaving or oscillating the electrode, will assist in keeping the work cool and in minimizing the stresses which in some measure are bound to occur.

One of the errors frequently made in the application of steel metallic arc welding is the practice of building up heavy layers of metal adjacent to the cast iron. When good fusion is obtained, the section of a deposited metal can be safely limited to one-half that of the cast-iron section.

Fig. 6. Part of Cast-iron Section showing Characteristics of the Weld and the Original Metal

The metal added in the square groove at the break offers a projection against which the adjacent sides of the fractured casting are drawn by the shrinkage of the subsequently added material, thereby overcoming one of the greatest troubles encountered in the welding of cast iron. The other grooves furnish additional strength and insurance against leakage of gases and fluids when welding cast-iron cylinders and containers. The method of "veeing out" the casting at the break was adopted from the practice followed in acetylene gas welding, and may be followed in cases where the carbon is found to be in the state which will permit good fusion between the casting and the added metal. The heavy sections of graphitic cast iron, as usually encountered, should not be veed, as the original surface of the casting offers a better quality of metal upon which to weld than that exposed by cutting below the surface. A less suitable condition is encountered as the cut is made deeper, because the farther from the surface the greater the amount of graphite in the cast iron.

Another disadvantage of the beveling method of preparation is the shrinkage of the filler material, which occurs no matter how carefully the work is done. This shrinkage draws the bevels of the vee against the boss formed by the filled-in metal, with the result that the pressure exerted tends to lift the added metal from the casting. This, in fact, actually occurs in many cases.

By following the practice here recommended, which is the one most widely understood, the effect of shrinkage strains will be kept at a minimum by affording means of equalizing, balancing, and taking advantage of those stresses which cannot be entirely eliminated.

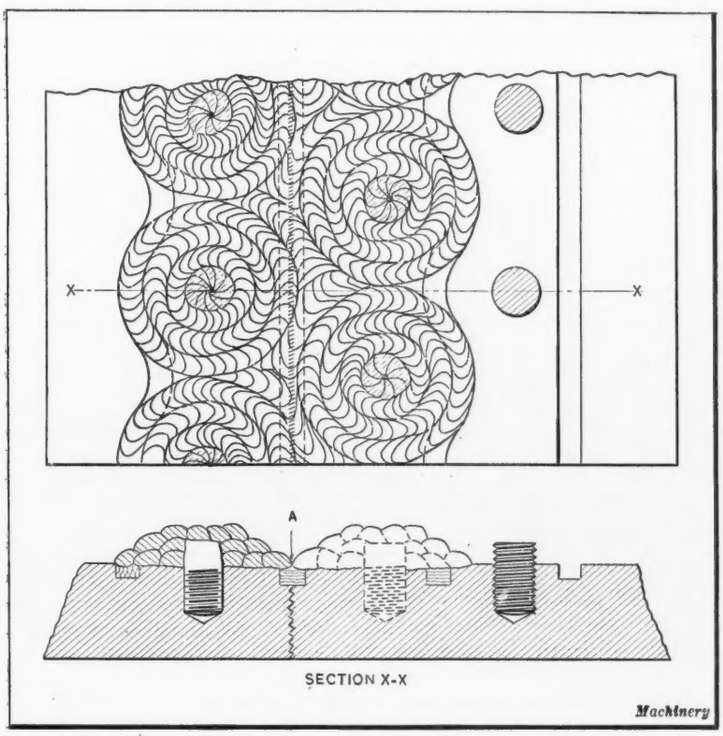


Fig. 5. Diagrammatic Presentation of the Procedure recommended in welding Cast Iron with an Electric Arc

Metallic Arc Process Using Cast-iron Electrode

It is the usual procedure in welding to use filler material which has the same characteristics as the material of the work and which will respond to the same treatment. It is obviously necessary that the amount of expansion and contraction of the parent and added materials be the same, and that good fusion of metals be secured. It is a logical procedure, then, to use filler material having a similar analysis to that of the part being welded, with a suitable allowance in the physical condition of the filler material to compensate for losses of its constituents caused by the effects of the arc. Electrode material for welding cast iron by the use of an electric arc should therefore consist of a cast iron high in carbon and silicon and containing small percentages of manganese,

silicon, sulphur, and phosphorus. Cast-iron electrodes of various compositions have been successfully used in conjunction with preheating the casting. The standard filler rods made for acetylene gas welding usually give very good results when protected by a coating of lime.

Fig. 6 illustrates a cast-iron section preheated to 1500 degrees F. and built up by the metallic arc process of welding, using a cast-iron electrode. The section was cut with a hacksaw to show that it can be easily machined, and was then broken to show the characteristics of the weld and the original metal. Note the dense, fine-grained structure of the added metal and the graphitic structure of the original casting. The added material is stronger than the original casting and is easily machined.

Preheating

Preheating is considered necessary in connection with arc-welding of cast iron if the best results are to be secured. Preheating relieves residual strains and compensates for expansion and contraction; it eliminates gas pockets and holes by holding the metal in a plastic or fluid state long enough after deposit to enable the gas to escape and the foreign matter to be released and floated to the surface; it aids in securing good cohesion of metals and reduces to a minimum the formation of the layer of slag; and it prevents chilling of the deposited metal and assists in the desirable slow cooling process.

In connection with preheating to relieve residual strains caused by expansion and contraction, it should be pointed out that breakage caused by these stresses does not always occur at the point where the greatest amount of stress is applied, but at a point where the strength of the section is less than that required to withstand the same stress if applied at that point. If the casting is of simple construction it is usually only necessary to preheat it at the points of stress application. The problem becomes greater as the intricacy of the casting increases, until it becomes necessary to preheat the casting all over in order to compensate for the liberation of the residual stresses. In addition to preheating, it is often necessary to reheat the casting following the operation. Reheating relieves strains caused by welding and anneals hardened sections of the deposited metal. In some cases very good results will be realized by thus annealing the weld in addition to preheating the cast iron before depositing the metal. One advantage of preheating is that the welding operation may proceed rapidly, while if the welding is done by depositing molten metal on cold castings the operation is exceptionally slow and tedious, since it is only practicable to add the metal a little at a time in order to confine the heat and shrinkage to a minimum.

Conclusion

A few years ago results obtained by the use of electric arc methods of welding cast iron were questioned. The progress made within the last few years has been such, however, that at present excellent results are obtained on the better grade of castings and a fair job is possible on castings of almost any kind. As a better understanding of the condition under which cast iron can be welded by any process is reached, the practice will become more general and will rapidly advance. The development of arc-welding cast iron will probably depend largely upon the developments in the use of certain methods of procedure here defined, in the applications of preheating, and in the development of an electrode for use in welding cold castings which will deposit a metal having a minimum coefficient of expansion.

* * *

The American Society for Testing Materials and the United States Forest Service have been designated by the American Engineering Standards Committee as joint sponsors for developing standard methods of testing wood. This action resulted from a canvass of the principal national bodies interested.

SCIENTIFIC PRINCIPLES OF COST REDUCTION

By J. H. LINDSAY, Master Mechanic, Armor Plate Machine Shop, U. S. Naval Ordnance Plant, South Charleston, West Virginia

It is obvious that any material gains in effective cost reduction must result from a systematic application of the records of past experience rather than from mere assumptions. It is an unfortunate fact that a great many executives are carried away by the glibness with which young and inexperienced students are able to recite academically stated principles and the ease with which they construct upon and around these principles a system that has the outward appearance of being the real thing.

The scientific principles of industrial organization are within easy reach of the man who has come up through the shop, and are the most valuable of any stock in trade that he can have. They are fundamental to economic production. An understanding of the factors and principles of industrial organization is a force that can be utilized by anyone, regardless of how humble his position may be.

A great many shop supervisors resent the interference and dictation of what they call "office men and book learning." This resentment is reciprocated. The two forces become radically opposed to each other, and cooperation and coordination is prevented. Whether shop executives like it or not, recorded data relative to all phases of production has come to be a potent factor in bringing about efficiency. Loose guesswork methods are no longer adequate. Executives who wish to hold their own and to advance must grasp those fundamentals that enable them to compare and determine the value of different methods and developments.

Recently a prominent executive stated that he had greater respect for the man who had worked himself up to a position of responsibility than he had for the technically educated man holding a similar position. The reason for this is obvious. This executive and others like him have come to learn that the man with a broad practical experience, supplemented and strengthened by an understanding of fundamental principles as they apply to practical work, can strip a theory of all its superfluities and make the practical part of it work.

What we need in order to put our industrial plants on a sound economic basis is to give more time to conscientious study of fundamental conditions. Every idea and suggestion relating to cost reduction should be given consideration. If those who control and direct the organizations that make use of American-made machine tools, of which we are justly proud, are wise in economics as well as in shop practice, we need have no fear of foreign competition.

The foregoing paragraphs have been written with a view to emphasizing the necessity of a thorough grasp of the fundamental principles upon which all system should be based. A ready-made method or system that is locally effective is the result of a close study of local conditions and needs, and the application of recorded data and original thinking to them. Such a system may or may not fit other conditions wholly or in part. If it fits other conditions, it may only bring about a result that is comparable with results obtained elsewhere, whereas leadership implies excelling results obtained elsewhere by the application of fundamental principles in a more thorough manner than has previously been done.

* * *

A joint investigation of the fatigue of metals under repeated stress has been conducted during the last two years by the National Research Council, the Engineering Foundation, the General Electric Co., and the Engineering Experiment Station of the University of Illinois. The results of this investigation have just been published in bulletin No. 124 of the Engineering Experiment Station of the University of Illinois, Urbana, Ill., copies of which may be obtained from the director of the Engineering Experiment Station.

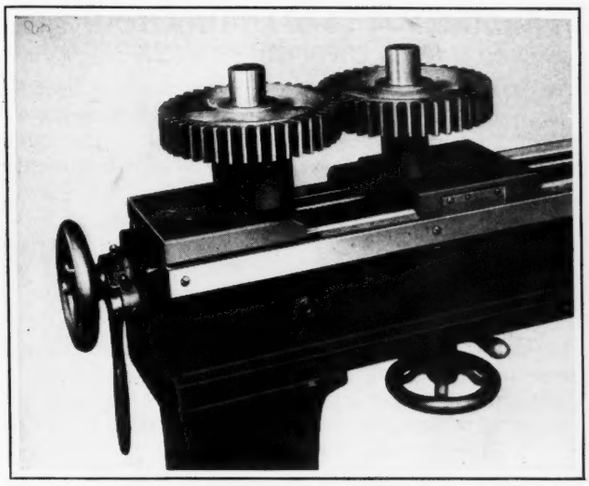


Fig. 1. Fixture for testing the Concentricity of Spur Gears

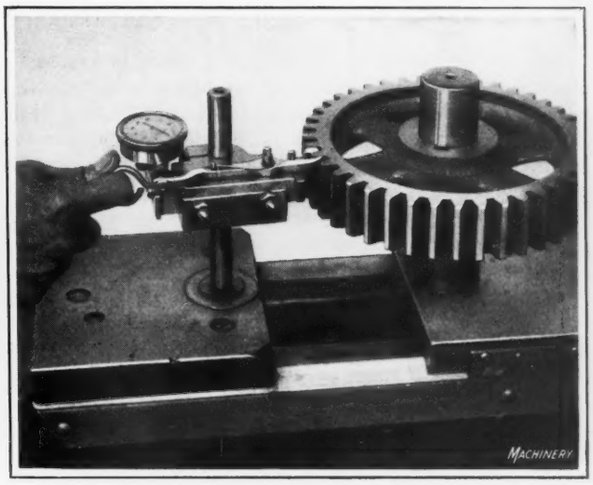


Fig. 2. Method of determining Uniformity of Tooth Spacing

Inspection of Spur Gears

By D. VAUGHN WATERS, Mechanical Engineer, Gould & Eberhardt, Newark, N. J.

CERTAIN qualities are required in spur gears, as well as in other types of gearing, for satisfactory service; these are uniform rotary motion, long life, and reasonably silent operation. In order to obtain these qualities, the following conditions must be met as closely as possible in manufacturing: The tooth curves should coincide with the basic involute for each gear; the pitch circle should be concentric with the axis of the blank; and the teeth should be of uniform thickness. Cutters are now made with a knowledge of basic principles and an accuracy of manufacture that enable a gear tooth contour to be selected and a cutter made which will produce this contour with a high degree of precision. Testing fixtures have also been developed to measure the accuracy of the involute curves on gear teeth. These fixtures have measuring elements which describe theoretically correct involute curves, and any deviation of the gear tooth therefrom can be instantly detected and measured.

In shops with an output of gears sufficient to justify their systematic inspection, certain standards should be established to define just how far a gear may depart from the fundamental requirements given in the foregoing: This article presents a short description of the practice of Gould & Eberhardt, Newark, N. J., in inspecting spur gears, with particular reference to the uniformity of tooth spacing and concentricity of the pitch circle relative to the axis of the gear.

The gears manufactured by this firm are component parts of the machine tools built by the concern, and are held to close limits of error. The inspection operations that do not relate to the spacing or concentricity of gear teeth are not within the scope of this article and therefore will not be dealt with.

Testing for Concentricity

The first operation is the testing of the blanks for concentricity, this, of course, being done before the teeth are cut. Each blank is rotated on a true arbor mounted in the centers of a testing machine. The anvil of a dial gage is brought to bear against the periphery, and any eccentricity can readily be seen. The cut gears are put on the studs of the gear-testing machine shown in Fig. 1, either in pairs or with a master gear, and when rolled carefully by hand, a slight eccentricity of the pitch circles is easily detected. This machine consists of a base somewhat resembling a lathe bed, a bracket near one end holding a vertical stud which can be changed for different sized holes in gears, and a movable slide with another stud mounted on it. There is also a scale and vernier for use in adjusting the studs to the correct center distance of the gears being tested. A screw and a nut inside the bed enable the movable slide to be adjusted, this mechanism being actuated by the handwheel seen at one end of the machine.

Testing the Uniformity of Tooth Spacing

The uniformity of tooth spacing is inspected by means of the fixture shown in Figs. 2 and 3. This consists substantially of a base, a slide, and a dial gage secured to the slide. On one end of the slide is fastened a fixed finger *A* which can be adjusted to different pitches, and at one side of this fixed finger is a movable finger *B* terminating in a lever, the end of which bears against the anvil of the dial gage. The ratio of the length of the lever end to that of the finger is such that each division on the dial of the gage indicates 0.0005 inch in tooth thickness.

This fixture is mounted on the gear-testing machine mentioned in connection with the rolling test. A gear to be tested is mounted on one of the vertical studs and the fixture secured in such a position relative to the gear that the fixed finger *A* enters a tooth space. The slide is next advanced by means of the attached handle, causing the movable finger *B* to enter the space on the opposite side of the tooth from the fixed finger. The dial reading is then taken, the gear rolled around, and the next tooth tested. This cycle is repeated until each tooth has been inspected and the error determined. It will be noted that this process does not check the circular pitch dimension of a gear, but insures uniform spacing around the blank. Fig. 2 shows the gear in place, being tested for uniformity of tooth spacing.

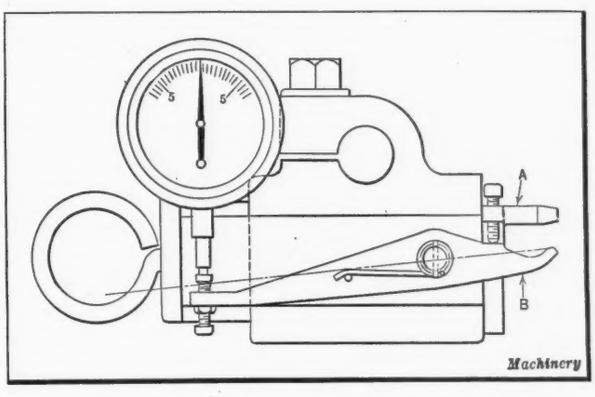


Fig. 3. Diagrammatic Representation of Fixture employed in Fig. 2

Ascertaining the Concentricity of the Pitch Circle

The inspection which closely checks the concentricity of the pitch circle with the axis of the blank is accomplished with the fixture used for the spacing test. For this operation, however, the fixed finger is replaced by a simple stop for the movable finger. The gear to be tested is mounted on a stud on the testing machine, as shown in Fig. 4, and held from rotating by means of a plunger entering a tooth space. This plunger is mounted on a bracket which can be adjusted to accommodate different sizes of gears. The testing fixture is then clamped on the machine so that when the slide is moved by hand, using the small handle referred to in the description of the previous operation, the movable finger will enter a space and bear on one side of the tooth about 180 degrees from the fixed plunger. The reading of the dial gage is then taken, the gear indexed one tooth, and the operation repeated. After all the teeth have been tested, if they have been cut eccentrically relative to the axis of the gear, the dial readings will increase and diminish uniformly from a mean value.

When an arbor is mounted in a lathe and it is desired to test its truth, this may be accomplished by bringing the anvil of a dial gage against the periphery of the arbor. The reading thus obtained is equal to twice the eccentricity, or the diameter of the circle described by the eccentric center rotating about the true center. With the gear-testing method just described, the result is the same as if a dial gage were brought to bear against the work-arbor upon which the gear was cut, thus providing a check upon the care exercised by the machine operator in setting up the work. Attention is called to the fact that if T equals the diameter of the circular path described by the eccentric center, the difference in the reading will be $2T$.

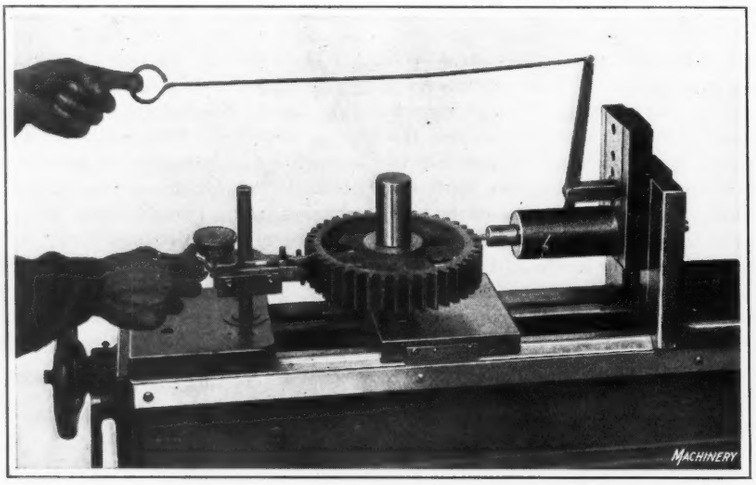


Fig. 4. Arrangement used for checking the Concentricity of the Pitch Circle

If the point of contact of the movable finger and the tooth flank does not lie on a line intersecting the axis of the gear and the fulcrum of the finger, the dial gage will indicate a difference in tooth position slightly in excess of that actually obtained. This discrepancy is so slight and the total difference in dial reading such a small amount, never exceeding 0.003 or 0.004 inch, that the testing fixture may be located in position as nearly as can be judged with the eye, and the possible error resulting from a slightly incorrect setting safely disregarded. When the high point on the gear comes opposite the testing fixture, the tooth is nearer the fixture by an amount equal to T than when the high point is opposite the plunger. This movement, taking place at the mid-position of the finger, will not affect the maximum and minimum dial readings, and may therefore be ignored. Denoting the difference in the dial readings from maximum to minimum as D, the value of T, or the variation a dial gage would show if it were possible to apply it to the pitch circle of the gear, would be $D \div 2$.

* * *

A study of the melting losses in aluminum metallurgical practice and the comparative efficiency of various types of furnaces has been completed by the Pittsburg Experiment Station of the United States Bureau of Mines, and the complete results will soon be available in bulletin form.

PRODUCTION OF MACHINE TOOLS IN THE UNITED STATES

The table on the opposite page, which has been compiled from information furnished by the Bureau of Census, shows in detail the production of machine tools in the United States for 1919. In that year, there were 496 establishments engaged in the manufacture of machine tools and accessories. Of this number, 403 plants were directly engaged in the production of machine tools, and 93 manufactured accessories. The total value of the product manufactured was $222,504,654, of which $212,224,708 worth was produced directly by the machine tool industry.

For a great many years Ohio has led all other states in the production of machine tools. In 1919 that state had 112 manufacturers, producing $65,521,575 worth of machines. Massachusetts came next with 56 plants, producing $23,885,863 worth of machine tools, while Rhode Island, with 18 plants, manufactured machine tools to the value of $23,080,978.

The table gives the total number of machine tool plants in the United States as a whole, and also the totals for the leading states engaged in this industry, together with the value of the machines produced in each. The table is further subdivided to show which states manufacture certain machine tools, giving not only the number of plants in the various states, but also the number of machines manufactured and the total value in each state of the different types produced. While some of the states lead in manufacturing one product or another, it will be noted that Ohio has the greatest number of machine tool plants, and also produces more individual machine tools than any other single state.

In another table compiled by the Bureau of Census, but not published here, it is shown that during 1919 the United States produced a total of $36,347,616 worth of metal-working machinery other than machine tools. Of this total Ohio produced only $4,180,531, while New York led with $9,250,240 worth of metal-working machinery. Illinois came second with $7,904,031 worth, and Connecticut ranked third, with $5,701,238.

* * *

PAMPHLET ON DEPRECIATION

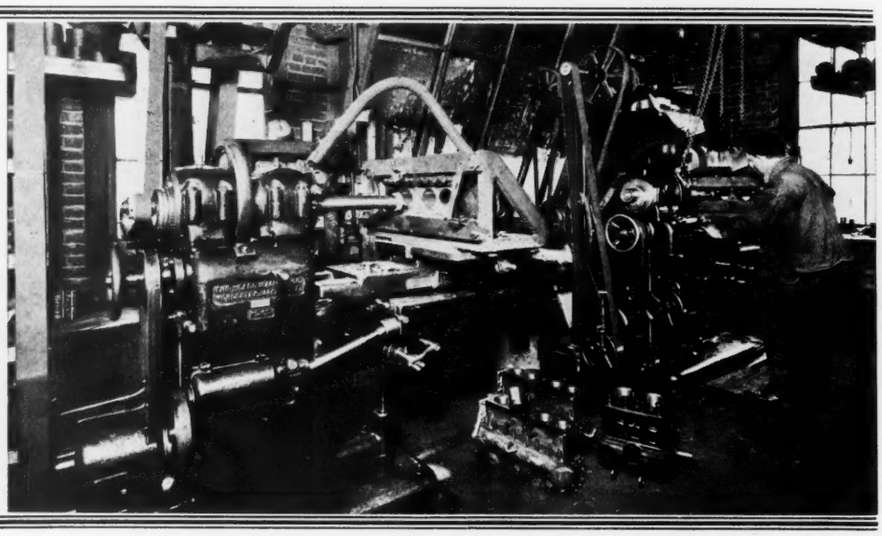
The fabricated production department of the Chamber of Commerce of the United States has published a pamphlet entitled "Depreciation—its Treatment in Production," which should be of considerable interest in view of the fact that depreciation is one of the most important problems in costs and general accounting. The material presented is based on extensive experience, and has been prepared in cooperation with many leading authorities in the accounting field, industrial engineers, manufacturers, etc. The topics treated are as follows: The need of charging depreciation into every-day cost; the relation of insurance and depreciation; adjusting depreciation to production; the controlling effect of obsolescence; advantage of standard rates of depreciation; and how the property ledger operates. The publication of pamphlets of this kind is part of the educational plan of the department, and copies will be supplied to those interested upon request.

PRODUCTION OF MACHINE TOOLS IN 1919

	Number of Establishments	Number of Machines	Value
Total number of establishments and value of products	496	.....	$222,504,654
Machine tool industry	403	.....	212,224,708
Subsidiary machine tool products from other industries	93	.....	10,279,946
State Totals			
Ohio	112	.....	65,521,575
Massachusetts	56	.....	23,885,863
Rhode Island	18	.....	23,080,978
Connecticut	44	.....	18,911,363
Pennsylvania	41	.....	18,089,791
Illinois	35	.....	15,728,950
Michigan	37	.....	13,324,988
Vermont	7	.....	9,669,745
Wisconsin	30	.....	9,637,254
New Jersey	18	.....	7,333,048
New York	37	.....	5,710,714
Indiana	19	.....	4,496,898
Kentucky	8	.....	1,280,706
All other states	34	.....	5,832,781
Totals for Different Types of Machine Tools			
Lathes			
Engine lathes	62	17,395	23,700,862
Ohio	22	6,806	12,673,981
Pennsylvania	6	134	1,759,737
Massachusetts	7	1,411	1,670,023
New York	5	2,010	1,394,223
Kentucky	4	675	626,101
Illinois	5	1,080	431,286
All other states	13	5,279	5,145,511
Turret lathes	23	4,724	10,285,484
Indiana	4	861	1,470,910
Massachusetts	4	218	584,849
All other states	15	3,645	8,229,725
Bench, and other lathes	56	7,603	4,739,116
Massachusetts	13	2,224	903,247
Illinois	6	1,302	870,638
New York	7	987	477,418
Connecticut	4	297	97,632
All other states	26	2,793	2,390,181
Milling machines			
Plain	34	8,531	7,386,734
Ohio	10	3,246	2,979,301
Wisconsin	3	2,022	1,835,280
New York	4	646	479,937
Connecticut	3	274	176,986
All other states	14	2,343	1,915,230
Universal	17	4,101	6,080,417
Wisconsin	4	1,814	2,154,976
Ohio	4	1,155	1,860,215
All other states	9	1,132	2,065,226
Vertical	13	1,146	2,375,742
Automatic	12	822	1,232,048
Other Types	21	1,751	2,989,793
Grinding machines			
Plain	52	9,352	12,999,651
Massachusetts	15	4,677	6,386,251
Pennsylvania	6	1,052	2,421,570
Ohio	8	1,073	1,005,377
Connecticut	6	762	491,074
Wisconsin	5	155	178,527
All other states	12	1,633	2,516,852
Universal	19	1,826	2,113,412
Massachusetts	6	771	520,307
Ohio	3	241	354,843
All other states	10	814	1,238,262
Other Types	28	4,244	1,956,064
Massachusetts	6	745	419,729
Connecticut	3	228	310,378
Ohio	4	350	238,303
Illinois	3	163	119,687
All other states	12	2,758	867,967
Drilling machines			
Radial	28	2,993	$6,215,541
Ohio	14	2,416	4,635,136
All other states	13	577	1,580,405
Multiple-spindle	17	1,738	2,296,841
Ohio	4	359	500,542
All other states	13	1,379	1,796,299
Sensitive	19	7,189	2,081,850
Massachusetts	4	2,182	1,064,102
All other states	15	5,007	1,017,748
Upright	20	9,854	2,291,897
Illinois	5	3,804	891,188
All other states	15	6,050	1,400,709
Screw machines			
Automatic	14	3,897	8,445,222
Hand	11	3,047	3,159,710
Ohio	4	2,365	2,642,132
All other states	7	682	517,578
Boring machines			
Horizontal	25	852	4,565,720
Ohio	7	343	1,448,449
Pennsylvania	5	126	1,340,532
Massachusetts	3	97	445,864
All other states	10	286	1,330,875
Vertical	13	864	4,458,356
Ohio	3	248	2,410,446
Pennsylvania	4	258	1,136,029
All other states	6	358	911,881
Planers	28	1,525	8,355,390
Ohio	9	869	4,154,315
Massachusetts	5	193	808,196
Pennsylvania	3	20	600,987
All other states	11	443	2,791,892
Presses			
Punching	24	33,404	5,626,245
Ohio	9	31,457	4,530,299
All other states	15	1,947	1,095,946
Other Types	31	4,159	1,464,161
New Jersey	5	980	616,458
Ohio	5	381	161,802
Illinois	4	247	37,020
All other states	17	2,551	648,881
Gear-cutting machines, all states	15	2,949	6,162,426
Hammers, pneumatic and other	25	40,121	5,104,993
Ohio	4	7,348	807,977
New York	5	471	288,851
All other states	16	32,302	4,008,165
Shapers	31	4,602	4,347,838
Ohio	10	1,875	1,662,301
Michigan	3	217	308,856
Pennsylvania	4	13	81,947
All other states	14	2,497	2,294,734
Pipe machines	9	43,422	3,280,593
Ohio	4	40,290	1,282,140
All other states	5	3,132	1,998,453
Shears, all states	17	1,791	2,004,616
Broaching machines, all states	8	580	1,418,236
Bending machines, all states	10	516	954,444
Portable tools	44	.....	10,913,004
Michigan	7	.....	2,882,729
Ohio	9	.....	2,650,146
Pennsylvania	3	.....	185,965
Connecticut	5	.....	58,604
All other states	20	.....	5,135,560
All other machine tools	184	.....	30,845,316
Massachusetts	17	.....	6,346,693
Ohio	31	.....	5,646,693
Rhode Island	11	.....	5,131,023
Connecticut	14	.....	4,459,880
Michigan	18	.....	2,523,745
Pennsylvania	18	.....	1,354,358
Illinois	14	.....	1,258,778
Wisconsin	13	.....	1,033,122
New Jersey	11	.....	735,506
New York	15	.....	686,641
Indiana	7	.....	590,683
All other states	15	.....	1,078,194

Machining Pistons in the Repair Shop

Second of Three Articles Describing Methods and Equipment Commonly Used in Automobile Repair Shop Practice



THE methods used in the Frostholm Bros. shop in Syracuse, N. Y., for machining pistons require only standard machine tools in connection with some special fixtures. This company manufactures cast-iron pistons in standard sizes and in sizes from 0.001 to 0.062 inch oversize. However, the use of aluminum alloy pistons with a split skirt having from 0.001 to 0.002 inch clearance in the cylinder bore is recommended for some motors. These lightweight alloy pistons can be fitted with less clearance than cast-iron pistons, and special features of design provide for expansion, so that the fit is not affected by cold or warmth.

Turning a Recess on the Inside of a Rough Casting

For the cast-iron pistons a complete line of patterns is carried in stock, and the rough castings are first machined by turning a recess on the inside of the skirt to form a seat for plugs used in locating the piston during the subsequent lathe operations. The set-up of the Hendey lathe in which this operation is performed is illustrated in Fig. 1. The work is chucked in a four-jaw chuck and the recess is turned by a high-speed bit held in an Armstrong tool-holder.

Boring Wrist-pin Hole and Turning Piston-ring Grooves

Fig. 2 shows two lathes, arranged back to back so that the pistons may first be drilled and bored for the wrist-pin in the American lathe shown in the foreground, and then passed to the Worcester lathe at the rear, in which the ring-grooving and turning operations are performed. For wrist-pin boring operations, a fixture of similar design to that shown in Fig. 2 is used in various repair shops. The fixture is keyed to the faceplate of the lathe, and on its main casting are two projecting lugs, one of which has provision for attaching a finished plug of the size required to fit in the turned recess of the piston. A central line is scribed on the piston and a similar line on the locating plug, so that when these two lines are brought into coincidence the work is centrally located. The lug at the closed end of the piston carries a square-head screw for securely locating the work against the plug while the hole is being drilled and bored. An Armstrong boring-bar with a high-speed bit is the tool used in the boring operation.

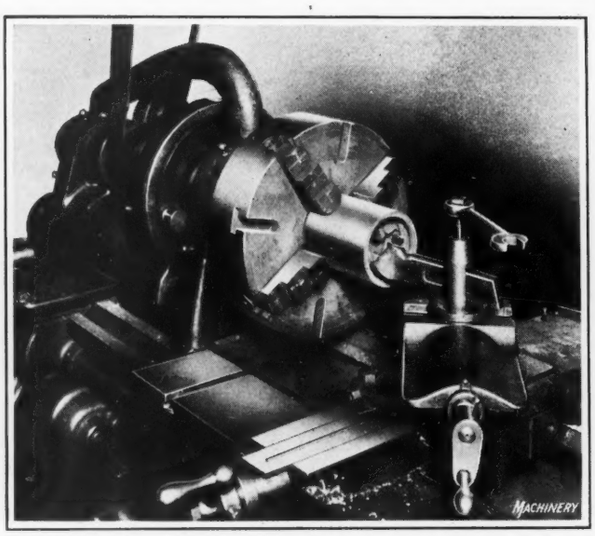


Fig. 1. Turning an Internal Recess on a Rough Piston

The grooving and turning operation is the next in the sequence of piston-finishing operations. A special center is used to fit the skirt end of the piston which also carries a driving pin to engage the wrist-pin lugs within the piston. The closed or ring end of the piston is supported by a regular 60-degree lathe center.

Other Wrist-pin Hole Boring Fixtures

Fig. 3 illustrates the set-up used at the Nixon Broach & Tool Co.'s shop for boring the wrist-pin holes in pistons. After boring, the holes are hand-reamed to size. The fixture, while similar in general appearance to that illustrated in Fig. 2, is of somewhat different design, and the work is located in a different manner. An angle-plate is attached to the faceplate of a Rockford tool-room lathe by dowel-pins, thus establishing a permanent location. The skirt end seats on a locating plug which is fitted in the fixture to accommodate different sizes of pistons. An arbor *A*, one side of which is milled flat, extends through a sleeve *B* in the angle-plate and is prevented from turning during the boring operation by a slab attached to the inside of the sleeve by two machine screws. The arbor extends through and into the piston and at its extreme end carries a V-block which operates against a coil spring interposed between its back surface and a shoulder on the arbor. The V-block seats on the wrist-pin bosses and holds the piston firmly while it is clamped from the closed end by a screw in strap *C* carried at the extremities of two tie-

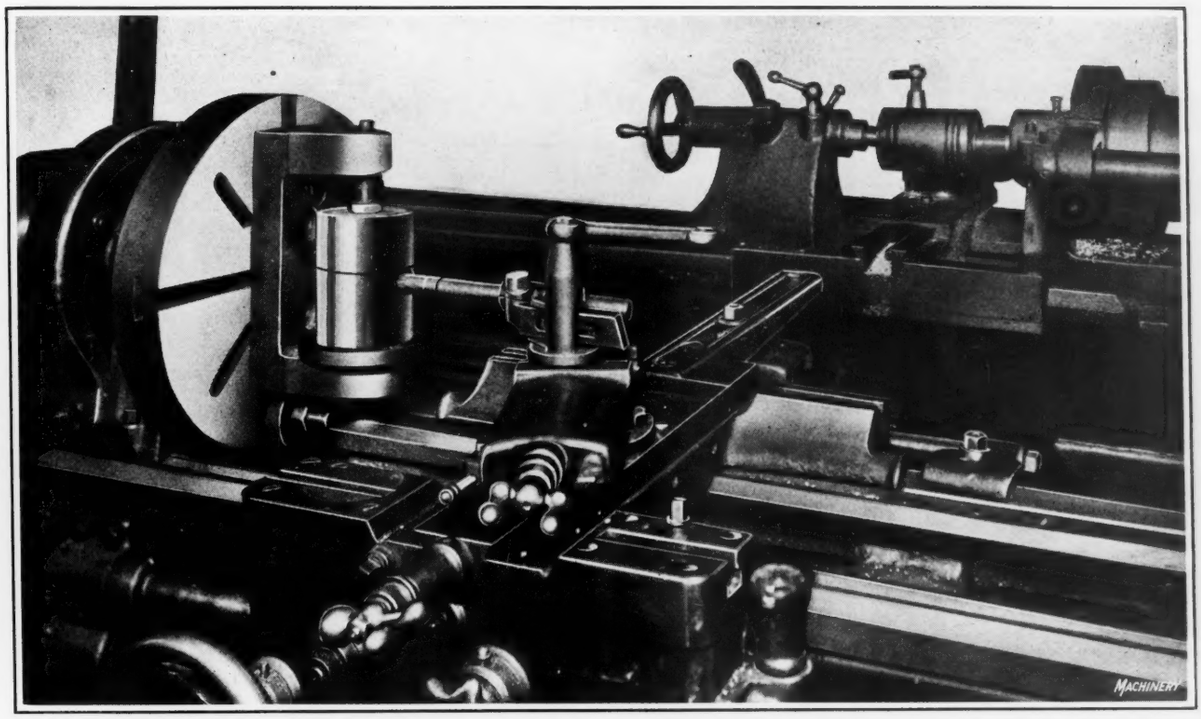


Fig. 2. Two Lathes, One equipped for boring the Wrist-pin Hole in Pistons and the Other for turning the Piston-ring Grooves

rods attached on each side of the angle-plate. This fixture, with proper locating plugs for the skirt end of the pistons, constitutes a self-centering device for any size piston.

The practice followed in the Saucke Bros. repair shop for finishing wrist-pin holes is not materially different from that in the two preceding cases. In Fig. 4 is shown a Davis lathe, to the faceplate of which a V-block fixture is attached. The piston is located in this V-block and adjusted by screws at the ends as required for centering it. A strap and two tie-rods are employed to secure the work in the V-block. The piston holes are first drilled, then finish-bored with a high-speed bit boring-bar, and finally finished by hand-reaming. The pistons furnished on repair work by this concern are manufactured from soft gray iron, the castings being made from their own patterns and afterward seasoned and heat-treated by bringing to a cherry red in a charcoal fire and allowing to cool with the charcoal embers.

Facing the Wrist-pin Bosses on a Drilling Machine

Inasmuch as the refitting of cylinders with over-size pistons sometimes involves the complete machining of the piston from the rough casting, it may be well to follow through some of the other operations in the Frostholm Bros. shop where this practice is followed. In Fig. 5 the operation of facing the bosses which surround the wrist-pin hole on the inside of the piston is illustrated. This work is done on a Barnes drilling machine, equipped with a sub-press type of V-block fixture. The posts of the base of this fixture carry a cast-iron clamp, which may be raised and lowered to suit different diameters of pistons, and clamped by knurled nuts. The clamp contains a finished central hole in which the shank of the piloted cutter-bar is guided. The cutter is a double-facing tool and is fed in alternate directions as required to face each boss. The bar extends beyond the cutter and acts as a pilot at the lower end to assure parallelism between the faces.

Finishing the Outside Diameter

The outside diameter of the pistons is first finished by rough-turning. They are then heat-treated, after which they are machined to within 0.010 inch of size. The skirt of a piston is usually ground straight, and at the head, where

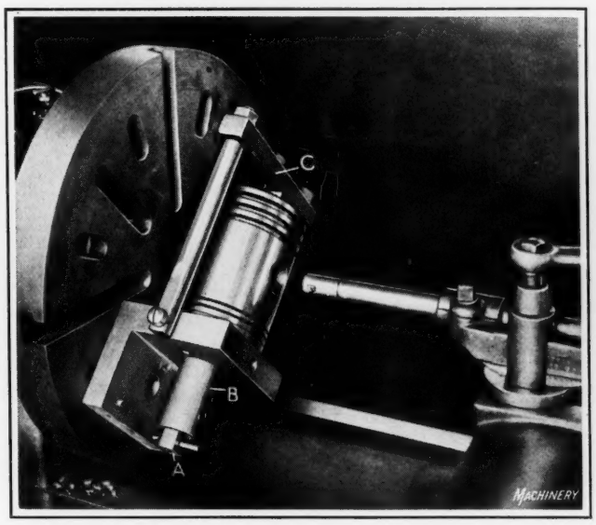


Fig. 3. Fixture for holding Pistons while finishing Wrist-pin Hole

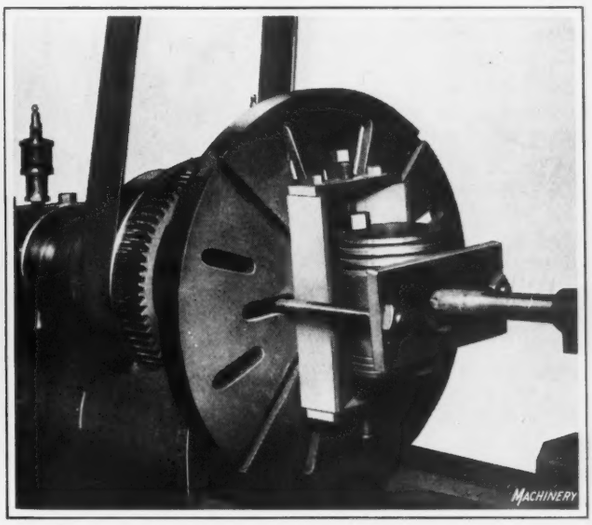


Fig. 4. Method of holding a Piston while boring the Wrist-pin Hole

Fig. 5. Drilling Machine and Fixture used for holding Pistons while facing the Wrist-pin Bosses

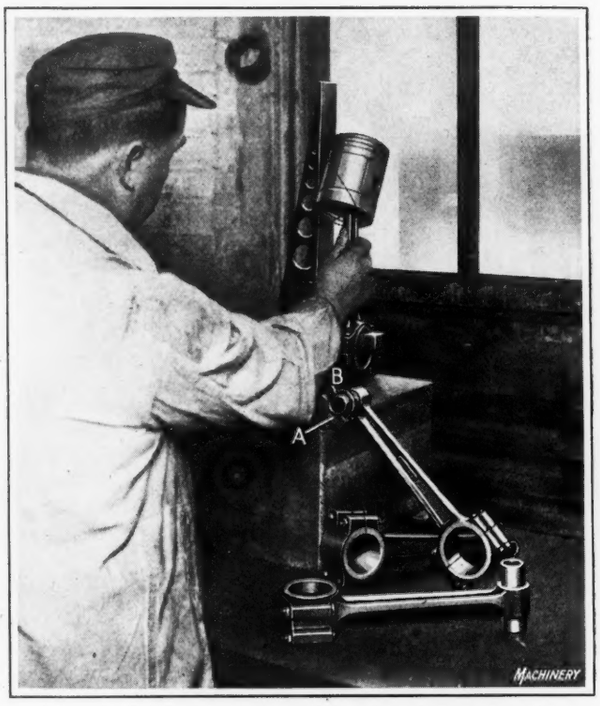


Fig. 6. Testing the Alignment of the Assembled Piston and Connecting-rod

the ring grooves are, it is necessary to grind to smaller diameters, reducing the size in steps toward the top of the piston. As there is more metal in the top, it is natural that it will expand more. The grinding is done on a No. 2 Brown & Sharpe cylindrical grinding machine, on the driving head of which a special taper center is used to engage the skirt end and drive the work, as shown in Fig. 7. For this operation a 12-inch diameter, 1¼-inch face aloxite wheel, made by the Carborundum Co., 24-36 grit, N grade, is used.

The practice followed by the Nixon Tool & Broach Co. in machining pistons is first to turn them to within 1/32 inch of the required finished diameter and then heat-treat them to remove the strains. After heat-treatment, they are finished by grinding on any standard cylindrical grinder, the rough-grinding operation removing stock to within 0.003 inch of the finished size. For both the finishing and roughing a 36-J Norton grinding wheel is used.

Testing Pistons and Connecting-rods

After the pistons have been finished and before they are reassembled in the motor, they are fitted with the proper size wrist-pins and assembled on the connecting-rod preparatory to testing for alignment. For this work Frostholm Bros. use a Dyer piston aligning gage in the manner indicated in Fig. 6. This illustration also indicates how the connecting-rod is tested before the piston is assembled. There are a number of connecting-rods shown on the bench with the piston-pins in place, and one of the piston-pins carries a parallel *A*, in one side of which a V-groove is cut in which the wrist-pin is seated by a coil spring *B* looped over it. This simple device is slipped on the end of the pin, and the connecting-rod placed on the fixture, as illustrated, in the same manner as when the piston is assembled.

If the test of parallelism and twist of the crankpin and wrist-pin holes is satisfactory, the surface of the piston is tested relative to the crankpin in the manner shown. By tipping the piston and moving the connecting-rod so that the surface to be tested passes by the vertical gage surface, and watching for the appearance of light as the two surfaces are brought into contact, the amount of deviation from perpendicularity with the crankpin hole is readily detected. For straightening the connecting-rod to overcome any inaccuracy that may exist, either a vise with special jaws or an arbor press may be employed, according to the equipment available in the repair shop.

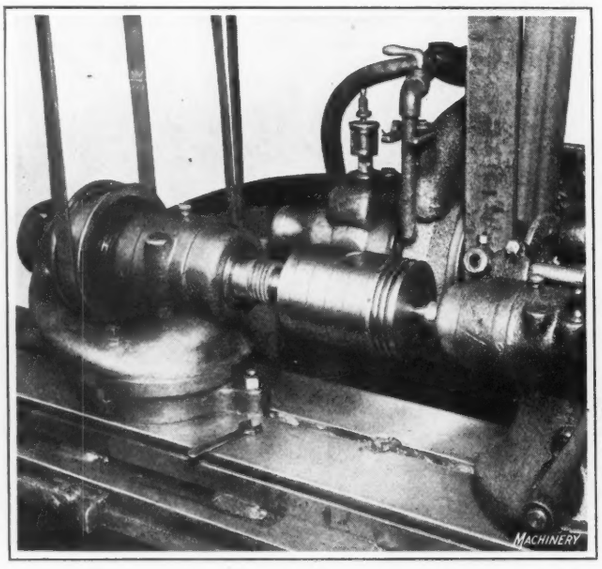


Fig. 7. Finishing the Outside of a Piston on a Cylindrical Grinder

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STATISTICS ON MACHINE BUILDING FOR 1921

The Census Bureau has begun to collect statistics for the year 1921 covering machinery of various classes, including machine tools and metal-working machinery. The 1921 statistics will be made very complete, provided the Department of Commerce obtains the necessary cooperation from the various manufacturers in this field. The success and value of the statistical information will depend largely upon the rapidity and accuracy with which manufacturers make the reports asked for by the Department. Blanks will be sent out to all the manufacturers in the field to be filled in and returned to the Bureau of Census. The information thus obtained, when collected and tabulated, will be of value to everyone in the entire machine-building field, and for that reason the data necessary to compile these statistics should be freely given.

The French Machine Tool Market

By W. P. MITCHELL

Paris, January 10

RECONSTRUCTION of industry since the armistice has demanded all the new equipment that economic conditions would permit; but it has been the French policy to discourage purchases from abroad, assuring buyers that the French machine tool industry would be capable of furnishing equipment equal to that imported either from the United States or Germany, the two chief sources for both metal-working and woodworking machinery in France.

It was for this reason that after the armistice extensive transformations were made in many war industries with a view to supplying both the home and the export market with machine tools of French manufacture. Since that time these transformed war plants have produced—in some cases merely attempted to produce—in addition to metal-working and woodworking machinery of all classes, a great variety of mechanical accessories to modern life and industry, from sewing machines and typewriters to molding machines for foundries, and grain- and coal-loading equipment for docks and warehouses. Today there is a list of at least two hundred French manufacturers, making some types of machine tools, advertising their product in the technical and daily press, each competing with a product hitherto imported.

Since the armistice there has also been a great increase in the imports of machine tools. The market of France has proved itself susceptible of a development hitherto not believed possible. Yet many French manufacturers would have added still further to their machine tool equipment had they not been prevented from making any but the most urgent purchases by the present high cost, because many manufacturers realize the necessity of modernizing their plants. American machine tools, to be paid for by what the Frenchman calls a "three-dollar dollar," suffered more than the substitute home product when the latter was available, but even the home product price, as compared with the price before the war, was based upon at least a "two-dollar dollar," and often more. There remained the possibility of finding what was wanted in Germany. With a natural aversion to pouring gold francs into Germany to take the place of paper marks many French manufacturers would not buy from across the Rhine, but turned to Switzerland, Denmark, and Holland, often even then obtaining a German product.

French Trade with Germany

Germany, for the moment, is the natural source of supply for the varied industries of France. Owing to the low value of the mark as compared with American and English money, obviously that is where France will buy, and the recent Wiesbaden conference has aided this tendency.

During the first six months of 1921 France imported from Germany machinery and tools to the value of nearly 400,000,000 francs, whereas from the present almost inexhaustible resources in iron ore, France sold to Germany in the same period only 100,000,000 francs worth of iron ore, pig iron, and semi-finished iron and steel products. On the face of it, Germany profited, on this one item alone, to the extent of 300,000,000 francs.

French Trade with the United States

A comparison is made in the following between the imports into France from the United States during the first six months of 1920 and the first six months of 1921; and also between the exports from France to the United States for the same period. The values are given in francs.

IMPORTS INTO FRANCE FROM THE UNITED STATES

	1920 Francs	1921 Francs
Machinery of all kinds	351,835,000	259,587,000
Tools and hardware	84,650,000	22,869,000

EXPORTS TO THE UNITED STATES FROM FRANCE

	1920 Francs	1921 Francs
Machinery of all kinds	1,750,000	4,154,000
Tools and manufactures of metal	3,277,000	27,200,000

These figures should be carefully studied. Exports from the United States to France decreased more than 150,000,000 francs, while French exports to the United States increased in a remarkable ratio. France exported in 1921 more tools and manufactures of metal to the United States than she imported. The low figures for the exports of machinery to the United States indicate that France is not equipped to produce machinery to compete in price with American products. That this is true is evident from the fact that France still continues to import many classes of machinery from the United States, paying 50 per cent or more over the price of the French product. The main cause for the falling off of American imports is undoubtedly German competition.

French Machine Tool Requirements

There is a greater appreciation of up-to-date and efficient machine tools than ever before. The French customs figures indicate the change between yesterday and today. The importation of machine tools in 1913 amounted to 48,000,000 francs, or 23,735 metric tons. Of this, 12,512 tons came from Germany.

In 1919 the imports of machine tools into France rose to 226,000,000 francs, or 33,504 metric tons. In 1920 the imports were 384,000,000 francs, or 56,940 tons. During the first eight months of 1921, the latest for which complete figures are available, a falling off due to the general economic conditions is noted, yet the imports were 49 per cent above the imports in 1913, the comparison being on the basis of tonnage. While there has been a drop in the imports, it is not believed that this is caused by the absorption point of the French market having been reached. It is partly due to the French manufacturers' supplying the domestic market.

There are no statistics available to show the quantity or value of French machine tools actually produced, but the export figures give some indication of the status of the industry in 1913 and its later growth. In 1913 the exports of French machine tools amounted to 4600 tons; in 1919 to 3600 tons; in 1920 to 8700 tons; and in the first eight months of 1921 to 5250 tons (or the equivalent of about 7900 tons for the entire year).

With high tariffs intended definitely to protect this new industry and the low value of the franc as compared with the dollar, it is easily seen why American machine tools are not readily sold in France. The French manufacturers, in spite of the high cost of raw materials and wages, transportation, and fuel, have taken advantage of the situation, and are not likely to give up their competitive position in the future. France, with the reannexation of the mineral resources of Lorraine, and the acquisition of the admirably built German steel plants there, must develop home industries for utilizing all of this to the best advantage. This means to sell, not raw materials or unfinished iron and steel, but the highly finished product. This is the keynote of the French policy in the metal-working field. In the machine tool industry, the results may already be noted.

Assembling Watch Pinion Bearings

Methods and Equipment Employed by the Waltham Watch Co., Waltham, Mass.

THE bearings for the pinion staffs of a watch consist either of nickel composition bushings and jewels for the cheaper grade of watches or of jewels entirely for the better grade. The bearings are staked into the pillar plate to support the lower pivoted end of the staff, while the upper bearings are assembled into the top plates. Before the assembling process is performed, it is important to so grade the staffs and the jewels in which the pivots have their bearing that the least possible amount of play is produced, and yet so that the pinions can run freely.

Some interesting methods are employed for this assembling process in the plant of the Waltham Watch Co., Waltham, Mass. First, a special dial gage, shown in Fig. 2, is used to measure the diameter of the staff at the point where the bushing or jewel is to fit. The gage has a stop for locating this point, and a staff carrying a wheel *A* is placed between the jaws of the gage and against the stop for determining the measurement. In connection with the inspection work, a blank form is used, which is ruled into squares, there being one square for each of the two bearings of every staff that is to be assembled. There are ten vertical rows of squares to accommodate lots of ten watches which go through the assembling process at once.

The selective assembling methods used are as follows: The plates, wheels, and other parts are delivered to the assembling bench in trays such as shown at *B*, each of the compartments being numbered. As soon as the diameter of a pivot has been determined, it is entered in a square of the blank form referred to, this square being in the vertical column corresponding to the compartment of the tray from which it was taken and opposite the name of the staff. Thus, if the upper pivot of a balance staff were gaged, and if this pivot wheel were taken from the first compartment in the tray, the entry would be made in the square at the upper right-hand corner. After all the pivots have been thus gaged, recorded, and placed back in the tray, the work is delivered to another bench where the jewels are selected for each pivot bearing. The special forms, with the entries made at the previous bench, accompany the tray, and when the proper jewels have been selected they also are placed in small compartments of the tray and passed on to be assembled.

The jewels are contained in small glass vials, as shown in the illustration, each of which is properly labeled to designate the staff for which the jewels are to be used and the size of the hole. All the jewels which are to be used for a particular set of bearings are graded by steps of 0.0005 centimeter (about 0.0002 inch) and by following the notations previously made on the form, the proper vial from which to select the jewel can be determined. After the jewel has been taken from the vial, it is gaged by a graduated needle gage *C* for diameter of hole, after which it is placed on the particular square which will indicate a running allowance between the hole of the jewel and the gaged pivot of the staff of 0.001 centimeter. The unit of measurement used at the Waltham Watch Co.'s factory is the centimeter. Fig. 2 shows a number of these jewels properly located in the squares of the blank form referred to.

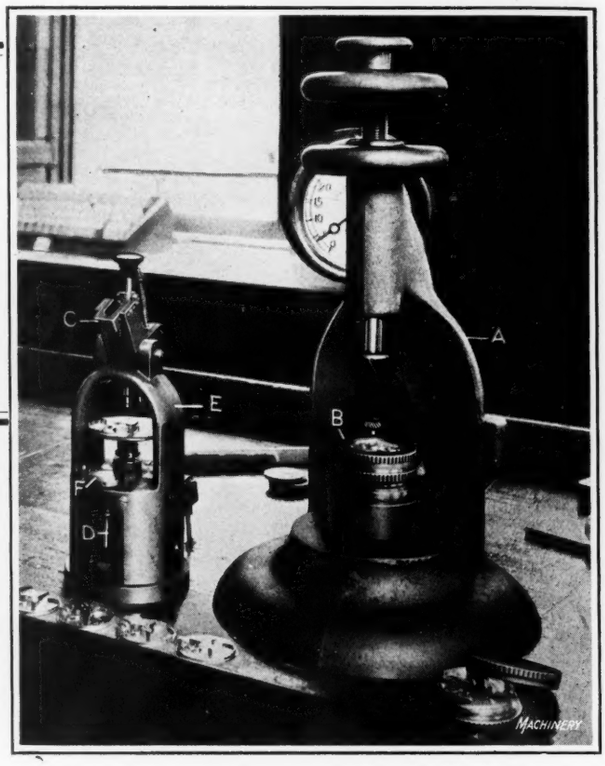


Fig. 1. Presses on which Watch Jewels and Bushings are staked in the Plates

In addition to the determination of the running qualities between the pivot and the jewel hole, the degree of fit between the outside diameter and the hole in the plate in which the jewel is assembled is also inspected. The jewels, or bushings, as the case may be, must fit into the hole and still be free to move up or down. This establishes only one limit, that is, the upper limit, but if the jewels are too loose this will be discovered when they are being staked into the plates. Some of the jewels are set into the plate by being screwed in, while others are staked by the use of small bench presses, as shown in Fig. 1.

Staking Jewels and Bushings

The jewels in the lower plate are staked first, an air-operated press such as shown at *A* being employed. The punch must, of course, be long enough to extend through the bearing holes in the upper plates and reach the lower plate. The holder for locating the watch plate and its assembled parts consists of a flat disk with posts by means of which the watch assembly is positioned. After the watch has been thus located, a ring is screwed down to hold it securely in place. One of these holders is shown on the bench at the right of the press with the ring removed, and another on the table of the press at *B*, in readiness to have the bearings staked. The vertical posts of the main disk of this holder are of such height that they form the locating surfaces against which the jewels are pressed while being staked into position. An air pressure of fifteen pounds is used in this operation.

For the upper plates a foot-operated press *E* is used. This press is equipped with a sapphire punch so as not to abrade the jewel when pressure is exerted during the staking operation. It is necessary to predetermine the distance between the face of the sapphire punch and the jewel, and this is done by locating the assembly on a disk by means of posts, as in the staking of the lower jewels, and then safeguarding against crushing the jewel by the use of a special stop for the punch which is independently set for each bearing. This adjustment is secured by pressing down the knob shown at

Fig. 2. Equipment used for inspecting Watch Staff Pivots and Jewels

the top of the press, against the tension of a coil spring until the sapphire punch seats firmly on the vertical post of the locating disk, in which position it is secured by swinging the yoke *C* into position for locking the punch at the predetermined height. When the foot-treadle is depressed, pressure is transmitted through a toggle lever which bears against a stop-pin *D*, and raises the table to keep the amount of pressure within the crushing strength of the jewel. A graduated dial *F* is used to set the stop-pin accurately. The connecting-rod which joins the toggle lever to the foot-treadle is shown extending through the bench at the rear of the press.

* * *

SETTING UP LARGE WORK FOR PLANING

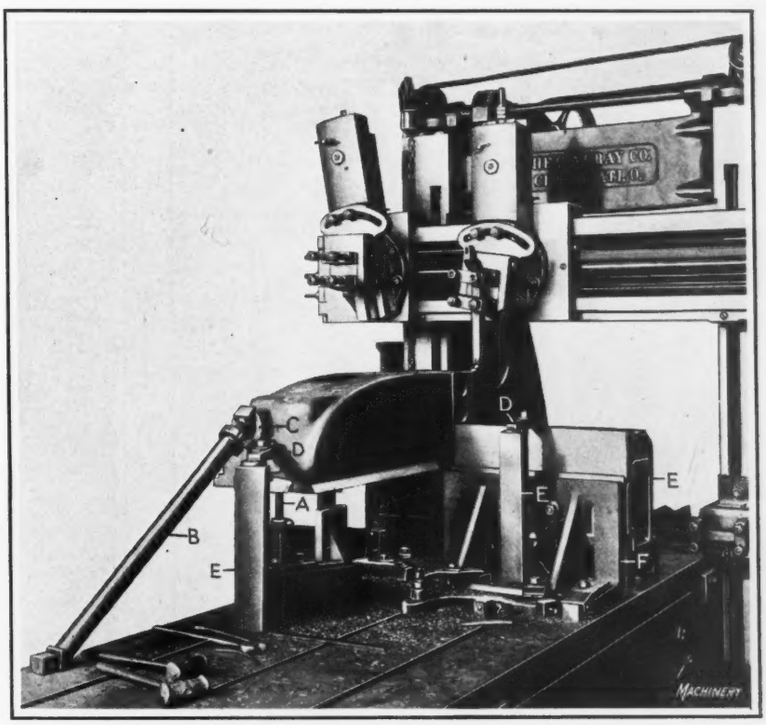
There are few types of machine tools that are required to handle as wide a range of work as planers. The methods of setting up these different classes of work naturally vary according to the size and type of the pieces to be planed. In setting up large castings, a considerable amount of ingenuity is often required to provide a sufficiently rigid support for the work in order to prevent it from springing.

Cast iron and other metals may sometimes be sprung out of shape through the application of relatively small loads. Such a deflection of the work produced by the pressure of the cutting tools on a planer may assume the form of either a temporary strain or a permanent set, but in either case the dimensions of the planed piece are almost sure to be seriously affected in cases where a high degree of accuracy is required; and to avoid trouble from this cause, it is necessary to take the greatest care to see that all overhanging parts of the work are well supported to prevent deflection. The accompanying illustration shows a good example of a set-up in which adequate provision is made for the support of the work. Here the body of a gear-cutting machine is shown set up on a G. A. Gray planer in the Brown & Sharpe plant. When the casting is delivered to the machine, the bearings have been planed for the cutter-head slide and for the work-holding spindle-head slide, in addition to some other surfaces, so that these may be used as locating points.

As set up on the planer the column that supports the work-spindle head of the finished gear-cutting machine overhangs in a manner that would be likely to cause serious deflection, if especial care were not taken to support the casting at this point. For this purpose there is a jack-screw *A* which may be adjusted under the casting to carry the weight of the overhanging part and any additional load imposed by the pressure of the tool. The work is further supported by an inclined jack *B*, at the lower end of which there is a wedge-shaped block that bears against a plug set in one of the table clamping bolt holes, while at the upper end there is a screw-operated V-block that enters hole *C* in the work. This inclined jack serves the double purpose of supporting both the vertical load and the horizontal thrust of the planer tool. The casting is held down on the planer table by two bolts and straps *D* arranged in such a way that one end of each of these straps bears on the work, while the opposite end is carried on a vertical strut made of a piece of 2- by 4-inch timber *E*. The bearing for the cutter-spindle head is bolted against angle-plate *F*, which is secured to the table by straps.

* * *

According to Census figures, 246,139 tractors were in use on farms in the United States at the end of 1919, and the farm equipment production and sales statistics of the Department of Agriculture show that 162,988 tractors were sold in 1920, so that a total of about 400,000 tractors are now in use in the United States. There are still 2,000,000 farms which represent prospects for the sale of tractors.



Method of setting up Large Castings for planing

Cutting Costs with Riveting Hammers

By FRED R. DANIELS

SEVERAL examples of cold-heading and rivet-setting operations performed on high-speed riveting hammers made by the High Speed Hammer Co., Inc., Rochester, N. Y., are illustrated in this article. One of the reasons that a high-speed riveting hammer is a valuable cost-reducing factor in metal-working plants is that the machine is easy to operate and regulate, so that boys and women are able to turn out as satisfactory a product as the more skilled machinist. The riveting hammer referred to consists of three main units—a pedestal, an attached hammer-head, and an adjustable anvil support. The hammer head carries a friction drive on one side and a pulley that revolves the spindle of the machine on the other, both being mounted on the crankshaft that actuates the hammer movement of the heading tool. The shock of the blows delivered is absorbed by the use of a hickory helve and large rubber bumpers.

The principle of hand riveting is incorporated in this machine in that the cold metal is caused to flow under repeated blows. The force required in delivering these blows for different classes of work is under the control of the operator through the friction clutch and foot-treadle by means of which the machine is operated.

The applications of the riveting hammer mentioned in the following are only examples of the wide field in which this type of hammer is in common use. For the delicate work required in typewriter construction and in the manufacture of camera parts and electrical apparatus, the high-speed hammer is regularly used. When parts are riveted with a hinge joint and freedom of movement is the prime requisite, the possibility of controlling the force of the blows permits rivets to be set without closing the hinge and causing the leaves to bind.

When rivets are pressed into place before riveting, two operators may be employed for the assembling and the riveting operations, one to press or hammer in the rivets and the other to do the riveting. Often the rivets are not a press fit, but may be assembled by hand in the parts to be riveted, and the work thus assembled passed to the riveter. In this case a boy can do the assembling work and keep the riveting machine in constant operation.

Riveting Rear Axle Drive Shaft Caps

The work being done in the set-up shown in Fig. 1 is the cold-riveting of forged steel hub caps to high-carbon steel rear axle drive shafts, 1¼ inches in diameter. The nature of the work performed in this operation is indicated at *A* in Fig. 3, from which it will be seen that the shaft extends 3/16 inch beyond the end of the cap, this metal being cold-riveted into the countersunk hole in the cap. This is an example of heavy cold-riveting, the work being done in the plant of the Reo Motor Car Co., Lansing, Mich. For work of this kind it will be readily understood that the peen must be properly shaped to fit the curvature of the cap so that as the tool revolves the rapid elastic blows will set the end of the shaft down even with the curvature of the cap. The work is seated on a special fixture and chucked from within

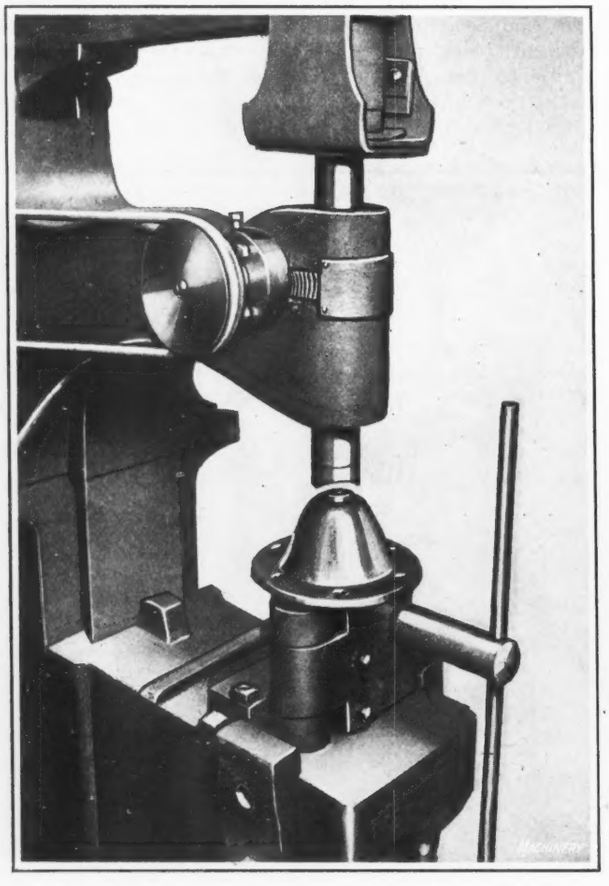


Fig. 1. Set-up for riveting Rear Axle Drive Shafts over Hub Caps

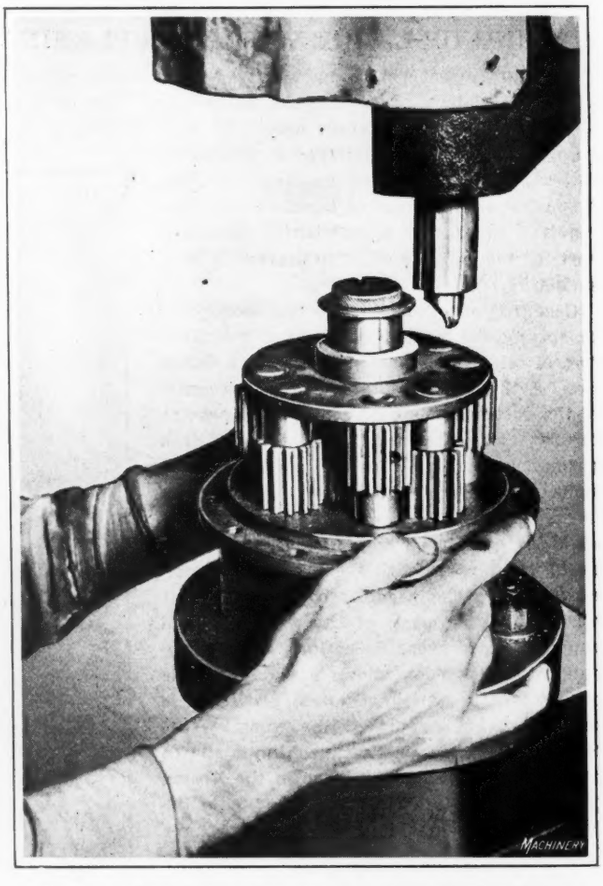


Fig. 2. Riveting Pins in Gear-case on a Power Riveting Machine

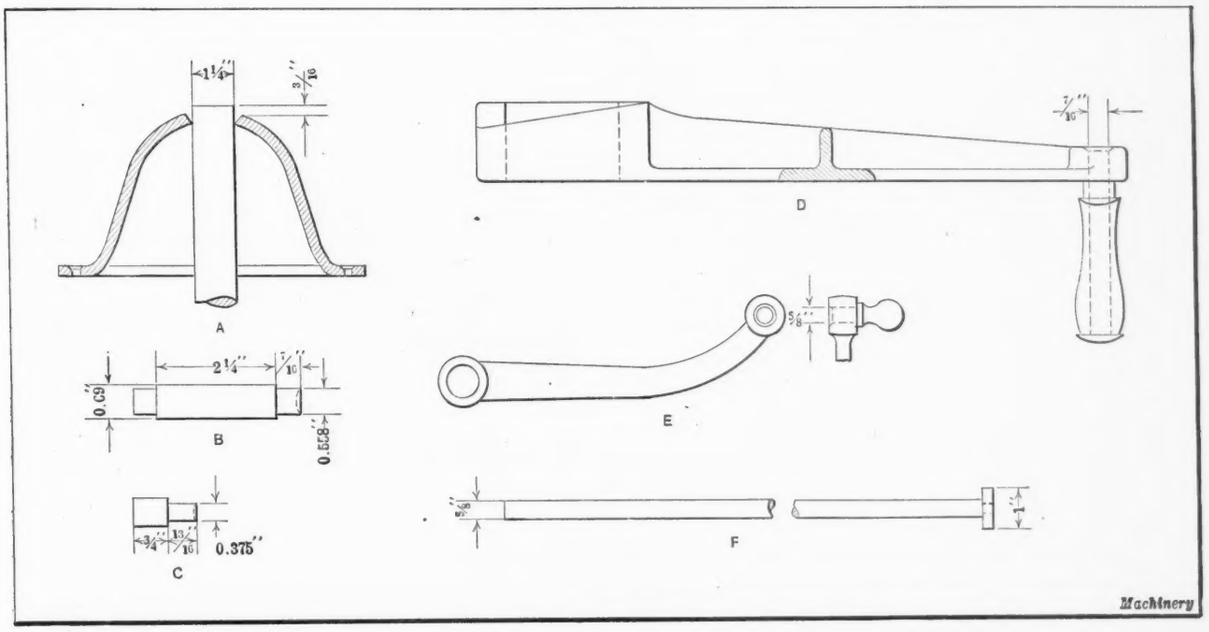


Fig. 3. (A) Shaft and Hub Cap before riveting; (B) Pin used in Differential Gear-case; (C) Wire Wheel Hub Flange Pin; (D) Automobile Crank-handle; (E) Pitman Arm; (F) Drill Rod with Cold-rolled Steel Head

by simply turning the lever-handle a part revolution. The work was formerly done by hand, by which method neither uniformity of product nor speed were realized. Using the sledge hammer the production time was four minutes per shaft; with the machine and set-up illustrated, the time is one minute per shaft.

Operations on Differential Gear-cases

Another manufacturing operation in the automotive industry is illustrated in Fig. 2; this is the riveting of eight heat-treated steel studs in automobile differential gear-cases. This also is a heavy riveting job. The work, which is performed in the New Process Gear Corporation's plant, Syracuse, N. Y., consists first of loosely assembling the side plates, pinions, and studs. These studs are 0.558 inch in diameter on the end to be riveted, as shown at *B*, Fig. 3. With the gears and studs loosely assembled in the plates, the work is placed on a fixture and a locking pin inserted through the central hole to align the gears while the first stud is riveted. After the first stud is set, the locking pin is withdrawn and the differential gear-case turned around to rivet a second stud located diametrically opposite the first stud. The operation continues from side to side in pairs until eight rivets have been headed over on the upper side of the case; then the work is reversed and the sequence repeated on the opposite side. During the riveting operation the gears are constantly manipulated by the riveter to detect any tendency for them to bind. The production for one man is from eight to ten completely assembled gear-cases per hour or an average of 144 headed studs.

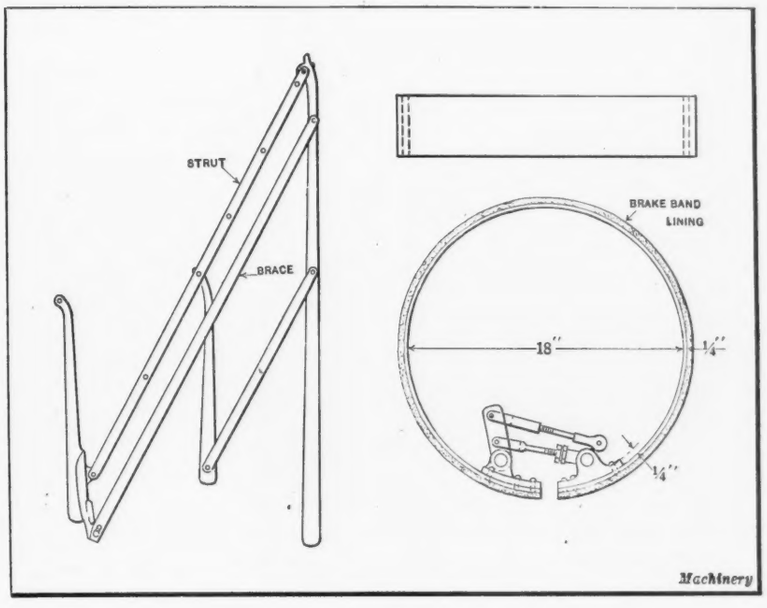


Fig. 4. (Left) Side Frame for an Automobile Top; (Right) Friction Brake-band

Application to Wire Wheel Manufacture

Many of these hammers are in use in the manufacture of automobile wire wheels in which their most common application is for riveting the six steel pins in the hub flanges. In one shop this job is handled by two men, one driving the pins into the flanges, and the other setting the rivets. In this way a satisfactory production rate can be obtained.

In another shop, the work is performed by one workman, the operation consisting of cold-heading six steel pins such as shown at *C*, Fig. 3. It will be seen that the end to be riveted is ⅜ inch in diameter. A fixture plate may be used to hold the rivets in the hub flange in the correct position for riveting after they have been pressed into the holes. The pins are set flush with the face of the flange which, of course, requires a straight-end peen. The production with one man working alone, is 75 hubs per hour, not including the assembling of pins, or 450 pins headed in one hour.

Riveting Crank-handles and Levers

At *D*, Fig. 3, is shown an engine starting crank on which the riveting operation is the setting over of the pin that passes through the wood handle. These steel pins are 7/16 inch in diameter, and some time is consumed in assembling them in the handles. The riveting operation is slowed up, because of the fact that more attention must be given to holding the overhanging end of the crank up at right angles to the face of the peen. The production is 75 cranks an hour.

The riveting of a nickel steel ball-end into a forged steel pitman arm for an automobile steering gear requires the

use of a large size hammer. The hammer used for this purpose in one plant is equipped with a special anvil in which the ball-end fits while the head is being set. A diagrammatic view of the assembly of a ball-end and pitman arm of the type referred to is shown at *E*. The diameter of the shank to be riveted is ⅝ inch and it is pressed into the arm on an arbor press, leaving about ⅛ inch projecting to form the rivet head. The head is rounded to ¾ inch diameter, using an oval-head peen, at the rate of 440 per hour.

The setting of a cold-rolled steel head 1 inch in diameter on the end of a 5/16-inch drill rod is a good example of machine riveting. This unit, which is shown at *F*, forms a driver used in the construction of nailing machines for box manufacture. It will be noticed that the drill rods are comparatively long and slender, and they must be firmly clamped on end during the riveting operation. The type of vise used for this purpose encloses the rod and is split longitudinally, being readily tightened on the rod by a hand-lever.

Riveting Brake-brands

The brake-band shown at the right in Fig. 4 is made of steel ¼ inch thick, and is 18 inches in diameter. It is covered with a brake lining which is assembled to it by copper rivets, this being a hand operation. The brackets that hold the lever-and-link device have a foot ¼ inch thick through which the brackets are riveted to the steel band. The illustration shows the position of these brackets after assembling. Steel rivets ¼ inch in diameter are used, sixteen of these being required to assemble both brackets. The production is 304 headed rivets or 19 brake-bands per hour.

Power Riveting in Chain Manufacture

Riveting the ends of pins on which the steel links of silent chains are assembled is regularly performed on the high-speed riveting hammer. The pins used in the particular size of chain illustrated in Fig. 5 are 9/32 inch in diameter, and the width of the chain is 4 inches. The riveted head is set over a washer and the operation must, of course, be so performed that freedom of movement is obtained between the links and spacers of the chain. The average production on this kind of riveting is 600 pins per hour.

Automobile Top Frame Riveting

The braces, posts, struts, etc., which go into the side frame of automobile tops are assembled by riveting, and practically all this work is done on power-driven machines. One example of work of this type is shown in Fig. 6 which illustrates the operation of riveting malleable iron forged clips to a frame post. This post goes into the frame of a Chevrolet automobile top, the work being performed in the American Forging & Socket Co.'s plant at Pontiac, Mich. The post is made of sheet steel with beaded joint, and is prevented from collapsing during the riveting operation by inserting a mandrel by which one end of the work is held, while the post rests on the specially formed anvil. Two flat-head rivets, 7/32 inch in diameter by 7/16 inch long are used to assemble these clips, the rivets being inserted in place by a boy or woman who then hands them to the riveter to be set down. In operations of this kind when it is necessary to handle the work in this way, a production of 2000 pieces in a nine-hour day is considered very satisfactory.

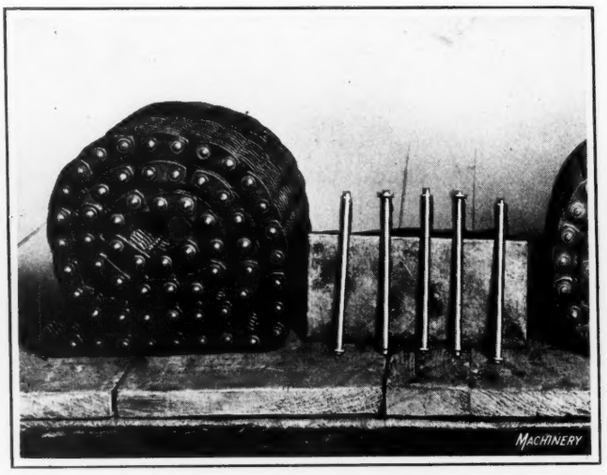


Fig. 5. Coil of Link Chain and Pins on which the Steel Links are assembled

At the left in Fig. 4 is shown the assembly of the side frame for an automobile top. The operation to which attention is here directed is setting the seven long rivets in the strut and the short one in the lower end of the brace. Rivets of different lengths are headed without changing the dies. This is accomplished by the use of two anvils which are operated to bring them into alignment with the peen by a foot-treadle. Two of these side-frame assemblies constitute a set, and the production is 250 sets per nine-hour day, or a total of 4000 rivets daily. This operation shows the possibilities of riveting work of an irregular or peculiar shape by the use of special mechanical devices and fixtures for holding the work.

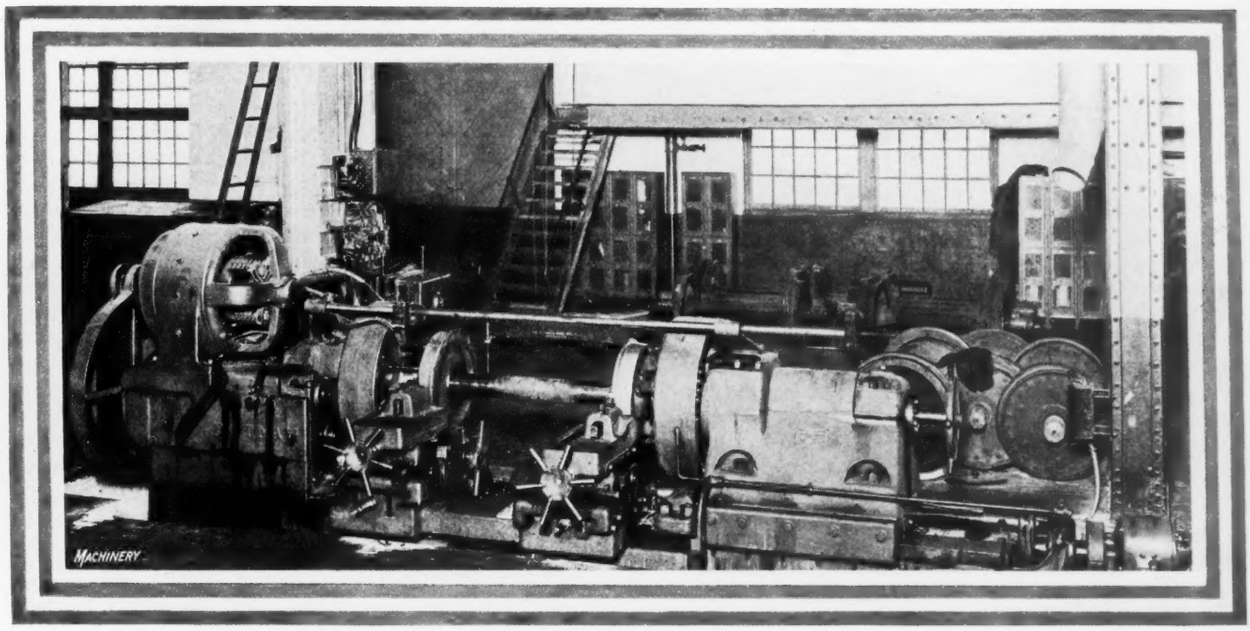
Fig. 6. Using Power Riveting Machines in the Manufacture of Automobile Top Frames

Power Riveting on Agricultural Implements

The riveting hammer is a common machine in the agricultural machinery plant. It is used in the making of malleable iron chains, shoe runners, mowing machine pitmans, and various other parts. In the plant of Henry & Allen, Auburn, N. Y., malleable iron ends are riveted to mowing machine pitman arms using eight ¼-inch rivets, four in each side. The heads are set at the rate of 400 per hour, 50 pitmans being completed every sixty minutes.

* * *

The use of treated wood block floors in factories, machine shops, foundries, and mills of various kinds, showed an increase in 1920 of over 80 per cent as compared with the 1919 figures, according to the Service Bureau of the American Wood Preservers' Association, Chicago, Ill. Creosote oil and creosote coal-tar paving oil were used as preservatives.



Electric Drives in Railroad Shops

Selection of Motors—Types of Motors—Application on Different Kinds of Machine Tools

By BERTRAM S. PERO, General Electric Co., Schenectady, N. Y.

INDIVIDUAL electric motor drive becomes practically a necessity in a railroad shop, because of the various machine tools required, and the nature of the work performed. This form of drive allows free use of overhead cranes, unrestricted location of machine tools, low maintenance, and provided the correct electrical equipment is used, high efficiency. As an illustration of the advantages, two views of the same woodworking shop are shown in Figs. 1 and 2. These might be called "before" and "after," respectively. The transformation has really enlarged the shop and increased the possible production of each machine, because the belt slip has been eliminated.

Selection of Motors

In selecting the electrical equipment for any shop, it is well to keep in mind a few general principles. A system using alternating-current motors on all constant-speed machines, with direct current for the remainder is probably the best. The second choice is direct current, because any machine tool can be successfully driven by this type of motor. If alternating current only is available, individual drive is still most desirable, even though there is no satisfactory commercial adjustable-speed alternating current motor, and gears must be used to obtain different spindle speeds.

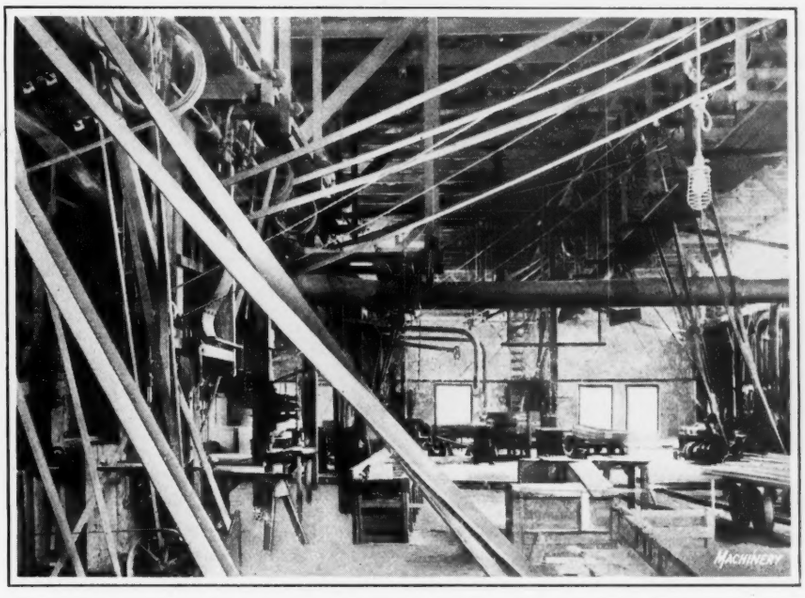


Fig. 1. View of Woodworking Shop before Installation of Motor Drives

Many machine tool manufacturers provide for speed changes through gears built as an integral part of the machine. This scheme allows a constant-speed motor to be used in many applications, but to obtain the speed increments possible with a direct-current, adjustable-speed motor would require an absurd gear combination. Very often, a simple gear change is used with an adjustable speed direct-current motor to obtain a wide speed range.

The squirrel-cage and wound-rotor alternating-current motors are the two forms generally used. The squirrel-cage motor is practically a constant-speed machine, and should be used for driving machine tools producing a constant load. The wound-rotor motor is capable of exerting greater starting torque with less current than the squirrel-cage type. The so-called "high torque" squirrel-cage motor is similar in appearance to the standard constant-speed machine, the only difference being in the rotor resistance.

Common Types of Direct-current Motors

The three types of direct-current motors generally used are the shunt, compound, and series. The series motor is not employed as extensively as in the

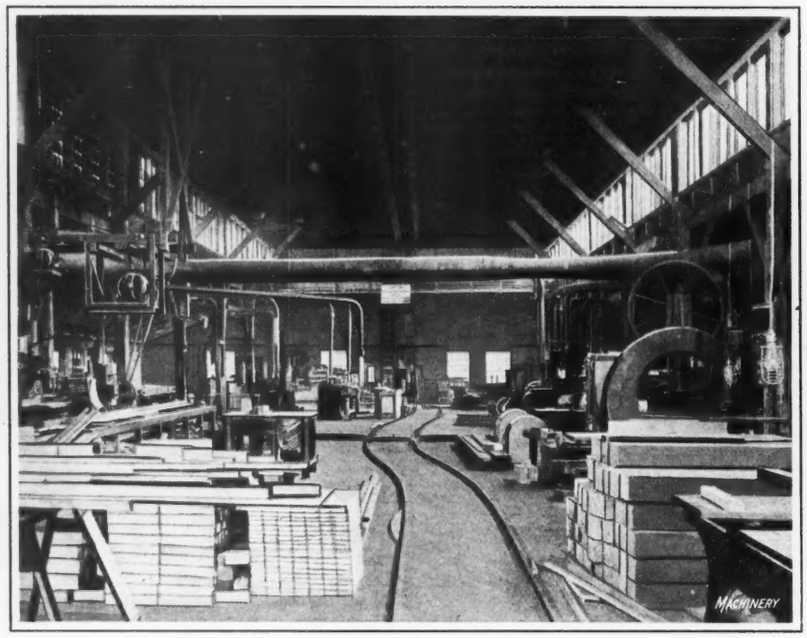


Fig. 2. Shop illustrated in Fig. 1 after Electric Drives were installed

past. Because the compound-wound motor does not attain as high light-load speeds, it is preferable for general use. The shunt-wound direct-current motor is essentially a constant-speed machine, the slip or reduction in speed from no load to full load being about 5 per cent for the average motor. This factor is inherent in any motor, whether of the alternating- or direct-current type. The speed of any direct-current motor is governed by the rate at which the armature conductors pass through the flux set up by the field magnets. This rate is a product of armature conductors per unit time and flux, and is constant, under definite conditions, in any particular motor. Therefore, in a motor where the field strength is constant, the speed will be constant, and the current will increase rapidly if the load tends to lower this speed.

When the field strength is varied, as for the shunt-wound adjustable-speed motor, a speed variation is obtained, because to maintain the particular "product" or "rate" with a varying field strength, will require a change in the number of armature conductors passing through the flux, per unit time. It is obvious that the armature speed must change to accomplish this. The squirrel-cage induction motor is comparable to the shunt-wound, constant-speed, direct-current motor.

Variable-speed and Adjustable-speed Motors

Variable speed must not be confused with adjustable speed. So-called "variable" speed is obtained (usually with a constant-speed motor) by introducing resistance in the armature circuit. The reduced speeds obtained by this method will vary with each change of load. This is not an economical scheme, because a certain part of the power taken from the line is wasted in heat generated in the resistor. This loss is dependent on the speed reduction, being equal to the output of the motor, when the speed is reduced to one-half. Besides the energy loss in the resistor, the motor output is reduced. The adjustable-speed motor uses a resistor in the shunt field circuit, and while there is a loss in this resistor, it is negligible, because the total energy input to the field is only about 3 to 4 per cent of the input to the motor; furthermore, since the field current is reduced at the higher speeds, this loss is decreased. The horsepower output of an adjustable-speed motor is constant in that the rating at high and low speeds is the same.

Compound-wound Motors

Compound-wound motors, which have a part of the field energized by the armature current, slow down under overloads, and speed up with light loads, due to the varying field strength. This produces a motor with a higher slip than the shunt machine, which is an advantage for certain drives. The average compound-wound motor has fields of which 80 per cent is shunt, and 20 per cent series. This means that with full load there is full field, while with 25 per cent overload, the series portion becomes 0.20×1.25, or 25 per cent. This added to the 80 per cent part, which is constant, makes a total of 105 per cent, causing a speed reduction.

High-torque Alternating-current Motor and Wound-rotor Type

The high-torque alternating-current motor is comparable to the compound-wound direct-current machine. This motor to all appearances is like the constant-speed squirrel-cage type, but the rotor is designed to have a greater resistance, producing greater slip at full load and higher torque at starting. When resistance is introduced in the rotor, there will be heat generated proportional to this resistance, and in the larger motors this heat becomes quite a factor; therefore, it is a good plan to use the wound-rotor type, connecting a permanent resistor outside the rotor, so as to obtain an equivalent slip, with the minimum heat inside the motor.

The wound-rotor or slip-ring type of motor is used for variable-speed service as required by cranes, bending rolls, etc. It is brought up to speed by connecting the motor to the source of power and gradually short-circuiting the external resistor connected in the rotor circuit, through collector rings mounted on the rotor shaft. This type of motor is well adapted to starting heavy loads, because the torque per ampere throughout the starting period is greater than that of a squirrel-cage machine. This is because the resistance in the rotor circuit can be adjusted to produce the best torque conditions for each speed during acceleration, whereas the resistance in the squirrel-cage machine is fixed

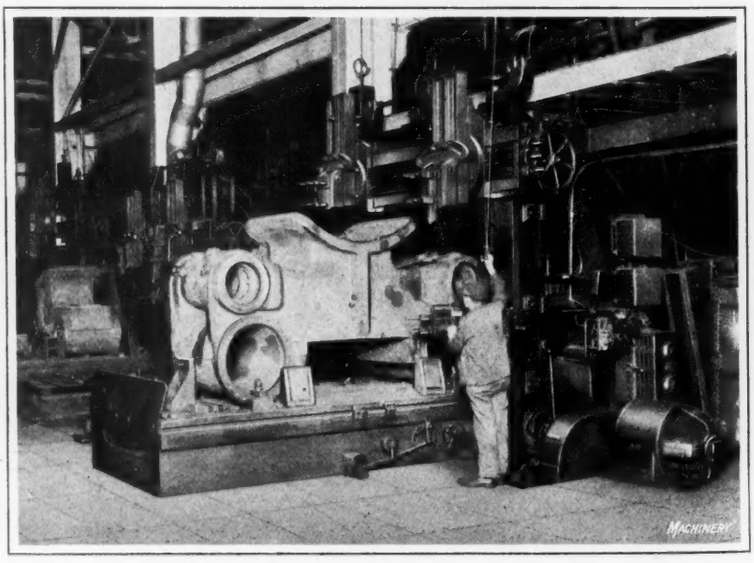


Fig. 3. Planer driven by 25-horsepower Adjustable-speed Reversing Planer Motor

and is comparable to the wound-rotor type of motor at one speed only.

Series Motors

In the series motor, all the field is produced by armature current. It is obvious that with a very light load there is practically no field, and the armature will run at a very high speed to maintain the "product" or "rate" referred to above. Also, with a 25 per cent overload, the field will have a strength of 125 per cent instead of 105 per cent as for the compound machine, and a lower speed will result. Commercial series motors do not produce the same speeds or torques on overload that a theoretical motor would, because the iron used in the fields becomes saturated after a certain flux is produced, and any current in excess of that which will saturate the fields has practically no effect on the field strength. Because of this condition, it has been found more desirable to use a motor with 50 per cent shunt and 50 per cent series on many of the machines heretofore driven by a series motor. The "50–50" motor will produce nearly the same torque per ampere, and has the advantage of a lower no-load speed. Approximately 150 per cent full load speed is obtained on light load.

Motors for Different Types of Machine Tools

In general, machine tools, can be classed in two groups. The first group includes those machines that are used for the purpose of removing metal by cutting tools or abrasives, such as lathes, boring mills, grinders, etc. Practically all machines of this group produce a continuous load, requiring a constant torque for any given condition of speed and cut. These machines should be driven by shunt-wound direct-current, or squirrel-cage induction motors. Because of its freedom from sliding contacts, the squirrel-cage induction motor is desirable for driving woodworking machines; if direct-current motors are used for service of this kind, the fire hazard is increased.

The second group of machine tools includes those machines used for forming or shearing metal, such as punches, bending rolls, etc. Generally, compound-wound motors should be used for driving this class of machines. There are exceptions to this, however, as for example, rotary beveling shears and punch presses used on rapid cycle work, where the load is practically constant for a certain operation, and in such cases a shunt-wound motor can be applied.

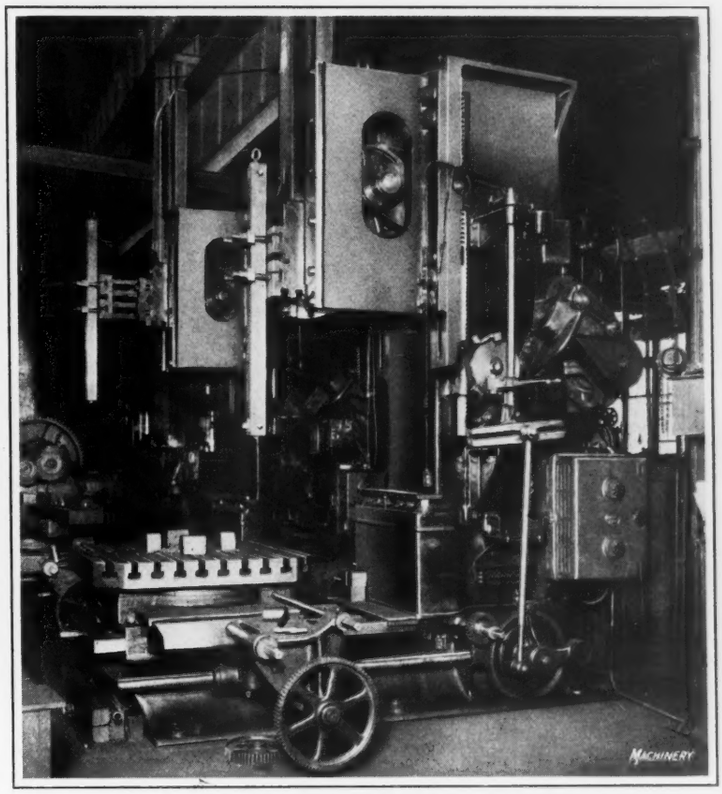


Fig. 4. Slotter driven by 15-horsepower Adjustable-speed Reversing Planer Motor

Type of Motor for Machines Having Flywheels

In general, all machines having flywheels which deliver energy during the working period, or machines requiring high torque intermittently, or for "break away" conditions, should be driven by a compound-wound motor. The reason for this application to flywheel machines is to allow the use of a smaller motor, and therefore greater efficiency. We have shown that the compound-wound motor has a greater slip or speed reduction, from no load to full load than the shunt-wound motor, and since the energy delivered by a flywheel is dependent on the speed reduction, a motor with a tendency to slow down with load, will allow a greater reduction in flywheel speed, without injurious overload currents on the driving motor, and enable the flywheel to furnish more energy for the work. After the work stroke is completed and before the next stroke, the motor accelerates the flywheel, thereby restoring the energy consumed. When a motor is correctly applied, it will be delivering a non-injurious overload at the moment the work is completed. This overload decreases as the flywheel attains speed, and then the motor furnishes only the power required for windage and friction load, until the next cycle.

The loads on presses and similar machinery usually last only a very short time, and even though the power required might be high for this time, a comparatively small motor, with several seconds to replace the energy in the flywheel, would take care of the load. Obviously, when the time between strokes decreases, there will be less time to restore the energy to the flywheel and the motor must be of greater capacity, up to the point where the work strokes are so rapid that the flywheel is of very little use, the motor delivering all the energy.

When a load demands high torque for "break away," such as for large lathe carriages, cross-rails, etc., the compound-wound

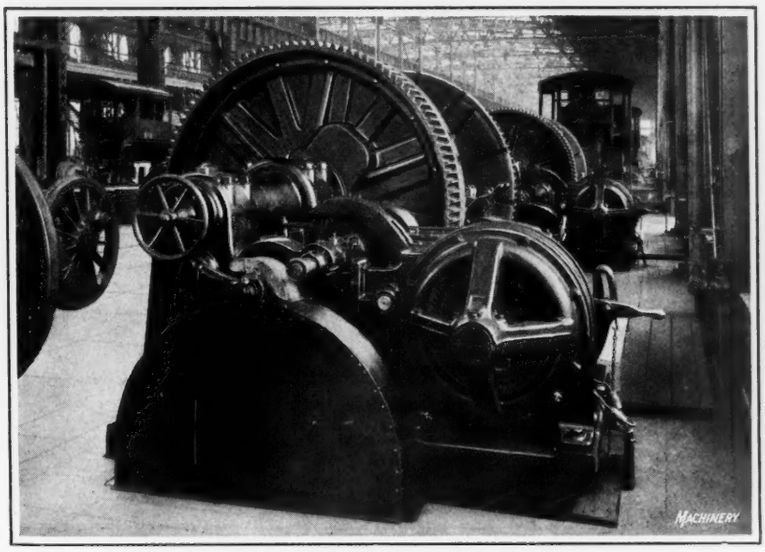


Fig. 5. Wheel Lathe driven by 75-horsepower Wound-rotor Alternating-current Motor

or series motor should be used, because, since the torque developed by a motor is a function of the field strength and armature current, and it has been shown that the field strength of a compound or series motor increases beyond 100 per cent for overload currents, the torque per ampere input is greater in these motors than in a shunt-wound machine. Series motors should never be belted because, should the belt break and remove the load, the motor would attain dangerous speeds.

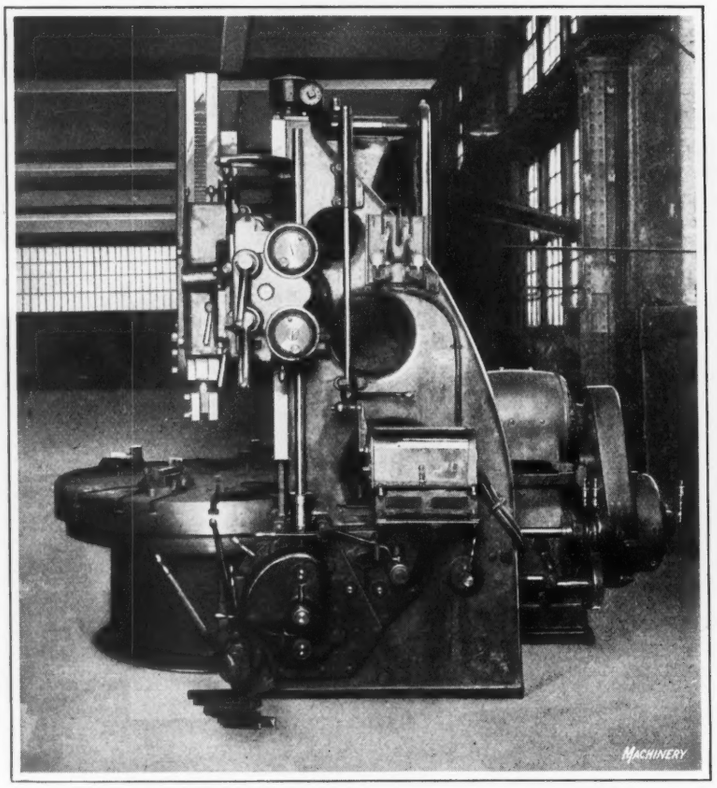


Fig. 6. Boring Mill driven by a 15-horsepower Adjustable-speed Motor

The Type of Control

In selecting the control for any application, it is good practice to arrange to have all control, such as starting, stopping, reversing, and speed changes from one handle or station. This is especially important on machine tools where the operator should watch his work while starting, such as with lathes, boring mills, etc. The controlling station should be convenient to the operator, when he is in the most advantageous position to watch his work.

Open type control should never be used when there is any chance of chips or other foreign matter coming in contact with any of the working parts. Automatic control is applicable to machines performing repeated cycles, such as planers, slotters, etc., or for motors driving pumps, air hammers, wheel lathes, milling machines, etc., but for engine lathes, bending rolls, or any machine tool where a set, or predetermined, speed is not applicable, manual control has been found to answer the requirements best. A control that allows the operator to change to the most efficient operating speed without leaving his work will usually permit the greatest production to be attained.

Under-voltage protection should be provided by the control. This means that if the voltage fails, the motor will not start unexpectedly when the power returns. An equipment without this protection might easily cause an accident. Under-voltage release, which means that the motor will restart, should not be confused with under-voltage protection.

Dynamic braking, which is generally used on reversing equipments, and sometimes on non-reversing control, causes a motor to come to rest, because the motor, driven by the stored energy in the rotating parts of the machine, acts as a generator, and changes the stored mechanical energy to electrical energy, which is transformed into heat in the brake resistor.

Examples of Motor Drives for Machine Tools

The direct-current reversing planer drive shown in Fig. 3 employs an adjustable-speed motor with a speed range of 250 to 1000 revolutions per minute. The motor is direct-connected, which thereby eliminates the losses caused by belt slip. By actual test, it has been found that with

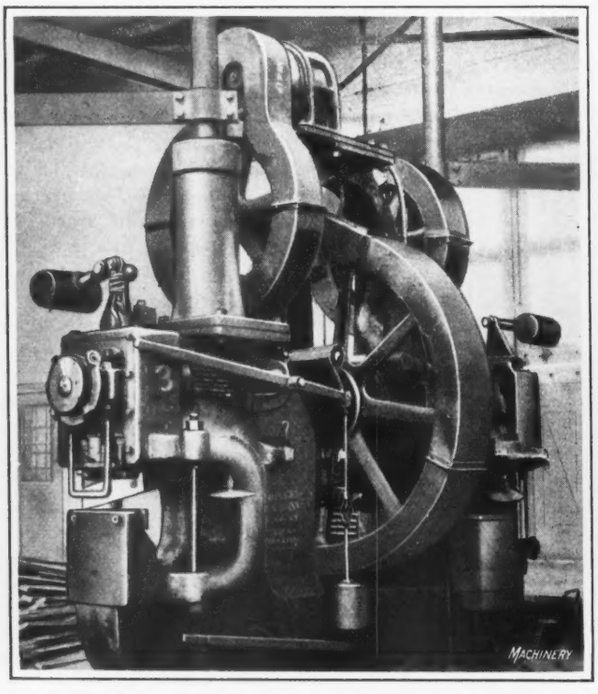


Fig. 7. Punch and Shear driven by a 10-horsepower Alternating-current Motor

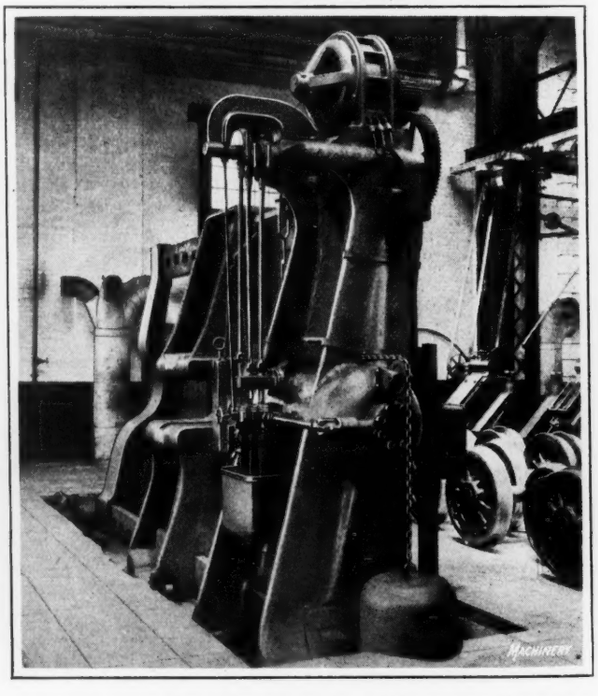


Fig. 8. A 600-ton Wheel Press driven by a 25-horsepower Alternating-current Motor

80 per cent load on a belted planer, the slip reduced the cutting speed 12½ per cent, and with slightly over 100 per cent load, the limit of the pulling power of the belt was reached. The control for the reversing equipment starts, stops, and reverses the motor in the shortest practicable time, and allows independent adjustment of either the cutting or return speeds. The cutting speed range is from 250 to 500 revolutions per minute, and the return speed, 500 to 1000. The same equipment is applicable to rack and screw driven slotters. The slotter shown in Fig. 4 is driven by a 15-horsepower reversing planer motor having a speed range of 250 to 1000 revolutions per minute.

The electrical equipment on the wheel lathes shown in Fig. 5 provides automatic acceleration and manual slow-down when hard spots are encountered. With the direct-current equipment, an adjustable-speed motor is used. It is possible to set the speed at some value within the range, and the control will cause the motor to accelerate to this predetermined speed each time. By means of a portable push-button, the operator can slow down the motor to at least 50 per cent speed, when the tool approaches the hard spot. After this is past, releasing the button allows the motor to accelerate to the set speed. When the stop-button is depressed the motor is brought to a quick stop by dynamic braking. A switch is mounted on the panel for emergency reversing.

Fig. 6 shows a motor-driven boring mill equipped with a drum controller and a 15-horsepower motor, having a speed range of from 550 to 1650 revolutions per minute. Boring mills of the larger sizes are generally provided with magnetic control. The punch and shear shown in Fig. 7, and the wheel press shown in Fig. 8, are driven by continuous-running, alternating-current motors, while the straightening rolls, Fig. 9, are driven by a wound-rotor motor with drum type control. The guide grinder illustrated in Fig. 10 is driven by a 10-horsepower induction motor. The methods of mounting these motors and the general arrangement of the transmission of power from motor to machine, are clearly illustrated. With the installation of new equipment in railroad shops, more electric drives may be expected.

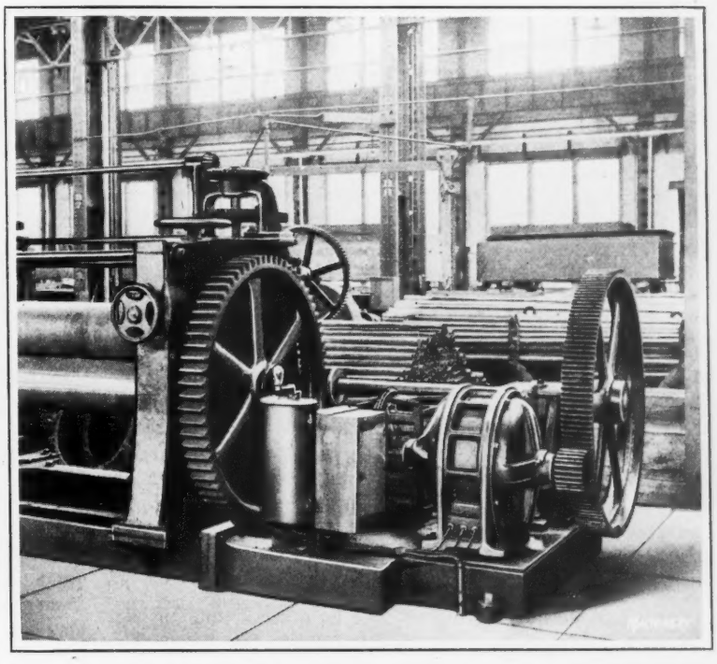


Fig. 9. Straightening Rolls driven by a Wound-rotor Motor having Drum Type Control

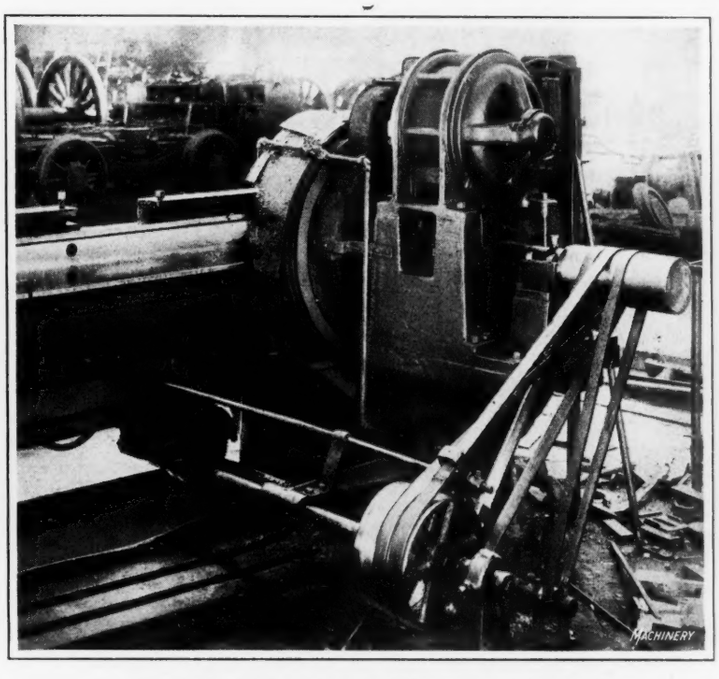


Fig. 10. Guide Grinder driven by 10-horsepower Induction Motor

ESTIMATED DEMAND FOR AUTOMOBILES

Since 1916, the increases in the annual output of automobiles have largely been accounted for by the increased output of Ford cars and of other relatively inexpensive makes. The total number of higher priced cars built annually since 1916 has not materially exceeded the number built in that year. Up to the present time the actual replacement of automobiles is estimated never to have exceeded 500,000 cars in a year, but it is believed that shortly the replacement market will mount to at least 1,500,000 cars per year. It is interesting to note that the present productive capacity of the automobile industry is more than 1,000,000 cars per year greater than would be required to replace the number of cars annually worn out or destroyed. In a pamphlet issued by Leonard P. Ayres, vice-president of the Cleveland Trust Co., Cleveland, Ohio, the statement is made that unless the exports of cars increase very much, the present productive capacity of the automobile industry is sufficient to double the number of cars in use within the next five or six years. It appears extremely doubtful if the foreign or domestic markets can be sufficiently expanded to take care of this capacity, and if they can, it seems probable that some motive power other than gasoline will have to be developed. Furthermore, it seems probable that very considerable price adjustments will have to be made within the next few years, as manufacturers must compete for purchasers whose buying power is comparatively limited.

* * *

HARDENING HIGH-SPEED CUTTERS

The best method for hardening high-speed form cutters is to use a muffle gas or oil furnace for heating the cutter. The cutter should first be preheated to a temperature of from 1600 to 1700 degrees F., and then placed in a muffle furnace and heated to a temperature of 2200 degrees F. As soon as the cutting edges have attained the latter temperature, the cutter should be removed from the furnace immediately and quenched.

The German Machine-building Industries

From MACHINERY'S Special Correspondent

Berlin, January 7

CONDITIONS in the industrial life of Germany at the beginning of 1922 are encouraging. Many firms give lower figures of idleness and larger numbers of orders on hand than ever before in the history of the various industries. Yet manufacturers and industrial leaders look into the future with deep concern, because they fear that, due to the increased costs of many raw materials which must be imported and the continual falling in value of the mark, the prices of all industrial products will soon be so high as to prevent German competition in the markets of the world and even sales at home.

Low Percentage of Unemployment in the Metal-working Industries

The small number of unemployed is directly due to the present favorable selling conditions. Within the workmen's organizations connected with the metal-working industries, the unemployment is only 1.31 per cent, this figure being the same as in March, 1907. Even in 1917 and 1918, when war materials were being turned out, the unemployment figure was 0.7 per cent. The maximum percentage of unemployment in the past has been 22.4, which was the figure in August, 1914, just after the outbreak of the war.

In a report for the week of November 6 to 13, covering 27,762 establishments and 2,052,900 workmen, 27,398 plants having 2,032,325 employes were working full time; 208 plants with 15,600 employes were working part time; and only 156 plants having 4975 employes were completely shut down. Whole industrial districts are working full time, and in the district of Essen only three plants having 855 workmen are operating on a reduced time basis. In the district of Cologne, three establishments with a total of 157 employes are shut down. In Berlin, one of the greatest industrial centers of Germany, there are 3213 plants with 251,775 employes. Of these, according to official reports, only 61 plants with 20,600 employes are running at reduced time. The figures given in the foregoing refer only to organized employes in the metal-working industries.

Orders Ahead for Machine Tool Builders

The statements concerning unemployment are reflected in the reports of industrial leaders relative to orders on hand. The management of J. E. Reinecker Aktien Gesellschaft of Chemnitz, recently announced that business is extremely brisk, there being more orders booked than ever before in the history of the works. All contracts for machines and tools are at fixed prices. "Sliding" prices could not be obtained, and consequently the prices of machines to be shipped abroad have been greatly increased in order to avoid risk of losses. This concern has declared a 20 per cent dividend to stockholders. These conditions may be considered typical of those existing in many machine tool plants.

Business Prospects in Allied Industries

In order to give an idea of the prosperous business conditions in industries closely allied to that of machine tool building, it may be mentioned that many brass works are so busy that only orders calling for delivery after the next four or five months are accepted. The price of brass sheets has been increased to 80 marks per kilogram (about 40 cents per pound, present exchange).

In the automobile field orders on hand will enable operation at full capacity during the next five months. Demands steadily increase, and come not only from home dealers but also from abroad. The various plants ask terms of delivery in from two to six months. The great increase in prices, especially of the important raw materials and of semi-finished products required in the manufacture of automobiles, is, however, a factor of great uncertainty which may considerably influence the future of this industry. For this reason, the leading firms, in order to avoid dangerous risks do not accept orders at fixed prices, and the buyer must therefore reckon with price advances during the weeks and months prior to delivery that were scarcely imagined at the time of placing the order.

The metal-stamping industries also report that the orders on hand are sufficient to keep most plants fully occupied during the coming months. However, the high prices of sheet metal will probably cause many shutdowns in this field in the near future. These high prices are principally due to the fact that Germany imports as much as 80 per cent of its iron ore.

In the world's commerce Germany now shares only 5 per cent, as compared with 20 per cent in 1913. Its exports in iron and steel products dropped from 6.5 million tons in 1913 to 1.7 million tons in 1920. These figures speak for themselves.

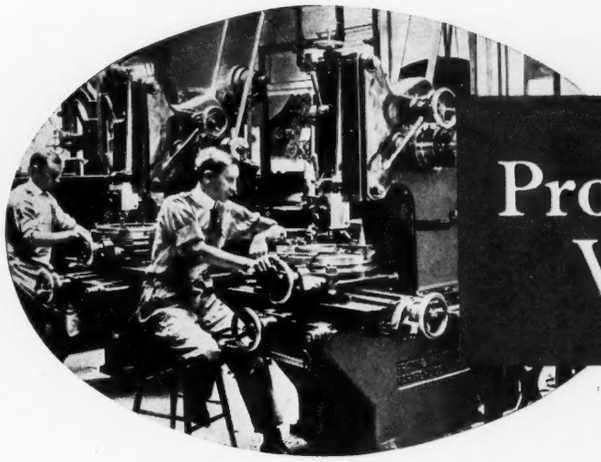
No Great Technical Progress During the Year

There has been little progress in methods and equipment in the machine-building industry during 1921, as the industry did not need to increase its production by building new and modern plants or by introducing improved working processes in order to compete with foreign manufacturers. The depreciation in the value of the mark has made wages in Germany, already low before the war, still lower in comparison with other countries. Thus German manufacturers can produce at much lower costs than foreign competitors. This fact secured for the machine tool industry a monopoly in the home markets, and gave sufficient protection against competitors abroad. German manufacturers, although able to under-bid foreign producers, still make good profits.

News Notes of the German Machine Tool Industry

The Zimmermannwerke Aktien Gesellschaft, of Chemnitz have paid a dividend of 12 per cent for the year, and have sold the greater part of their stock which had been on hand for a long time. This company has increased its productive capacity considerably and spent large sums in organizing its selling force. It has founded the Industrie-Lloyd, a selling organization which a number of other firms have also joined. Max Hasse Aktien Gesellschaft, of Berlin, manufacturers of turret lathes, have paid a 10 per cent dividend and have orders on hand to keep the establishment busy for four months. Wotanwerke Aktien Gesellschaft, of Chemnitz, have paid a dividend of 40 per cent; the Werkzeugmaschinenfabrik Union, of Chemnitz, 25 per cent; Sondermann & Stier Aktien Gesellschaft, of Chemnitz, 15 per cent; Schiess Aktien Gesellschaft of Düsseldorf, 16 per cent; and Bernhard & Alfred Escher, Ltd., of Chemnitz, 20 per cent. Many machine tool builders have greatly increased their capital, and several large stock companies have been formed.

Statistics are not yet available showing the total exports of machine tools from Germany during 1921, but it is expected that the figures will be quite large. France, especially, has bought a great deal of German machine tools, and considerable shipments have also been made to Holland, Spain, Switzerland, Italy, and the Scandinavian countries.



Production Work on Vertical Shapers

Operations Advantageously Performed on Shapers of the Vertical Type

By EDWARD K. HAMMOND

VERTICAL shapers built by the Pratt & Whitney Co., of Hartford, Conn., would scarcely be classed as machines that find wide application for the performance of manufacturing operations. However, there are numerous examples of detail work required in producing small and medium sized metal parts, for which a vertical shaper will give more satisfactory results than other machines. Such a case is shown in Fig. 3, where it will be seen that a slot *A* has been milled in work of the form shown. It is required to square the ends of the slot where they have been left curved by the milling cutter. To secure this result, the vertical shaper is equipped with a vise having its jaws in a vertical position, an end-bar *B* being placed under the work to support the downward thrust of the tool. Held in this manner, it is an easy matter for the shaping tool to square up one end of the slot, after which the work is traversed to bring the opposite end under the tool.

Shaping a Hexagonal Hole

When it is required to perform such an operation as shaping a square, hexagonal, or other shaped hole in a quantity of duplicate parts, the usual method is to handle the work on a broaching machine, provided the quantity of pieces is great enough to justify the making of a special broach. But if only a moderate number of parts have to be machined, the cost of a broach would make an excessively high tool charge against each part. For this reason it will be found more advantageous to handle a job of this kind on a vertical shaper.

An example of such a job is shown in Fig. 1. In this case it is required to produce a hexagonal shaped opening *A* in a moderate number of short cylindrical pieces. For this purpose, the work is laid out with carefully scribed lines, showing the exact shape and size of the hole; and the opening is started by drilling a round hole of a diameter slightly less than that of the inscribed circle of the hexagon. The work-holding fixture has a pocket in it to receive the piece to be shaped, and the bottom of this pocket is made with a shoulder to support the work, but open at the center to allow clearance for the tool under the work and to permit the chips to fall through. The piece is held down in the pocket by means of the straps shown in the illustration at *B*.

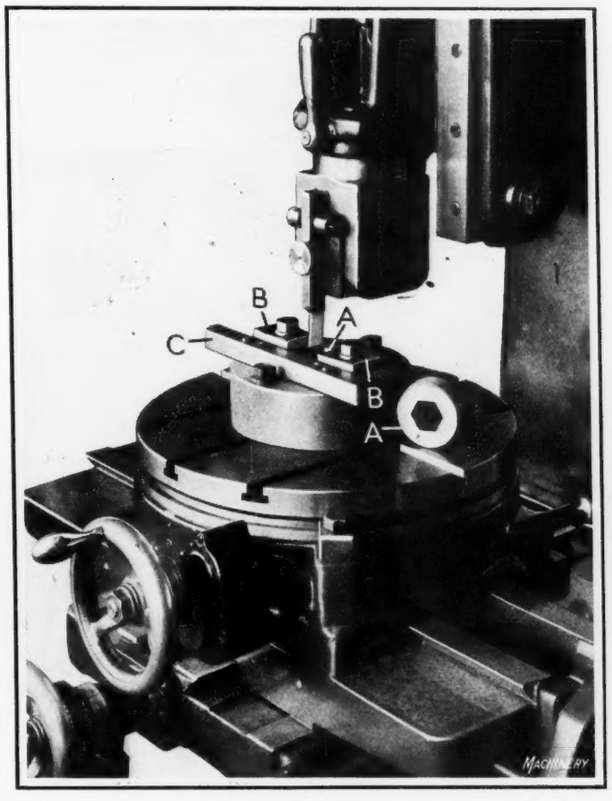


Fig. 1. Vertical Shaper equipped with a Fixture for Use in shaping a Hexagonal Hole

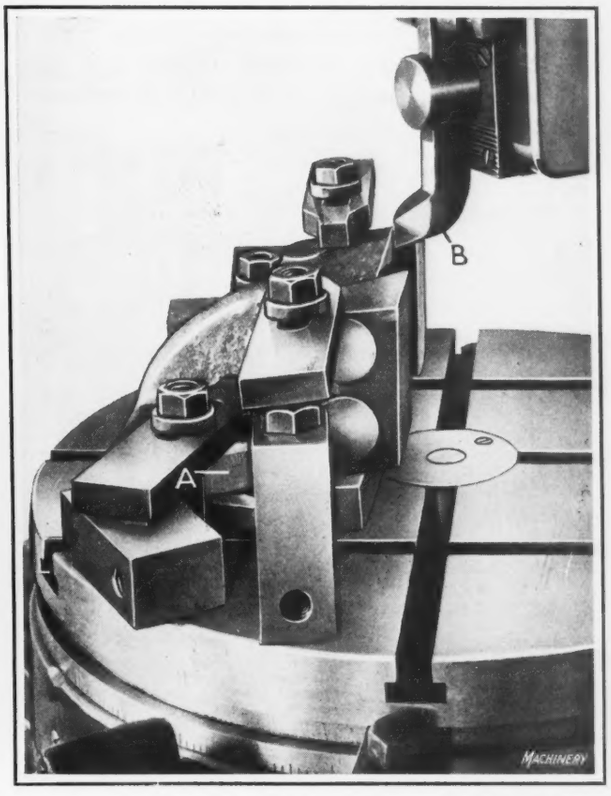


Fig. 2. Planing the Inclined Sides of a Dovetailed Bearing on a Vertical Shaper

In setting up this job, care is taken to align strip *C* accurately with the longitudinal travel of the table, by the use of a dial indicator mounted in the toolpost, and the work is then placed with one side of the hexagon parallel to strip *C*. The shaper tool is made of a width equal to one side of the hexagon, and is started in the round opening, the work being fed up to it until one side of the hexagon has been formed. After one side is finished, the work is indexed through 60 degrees, so that the next side of the hexagon can be formed, and this process is repeated six times to finish the job. The rotary table of the machine is graduated, which facilitates indexing the work.

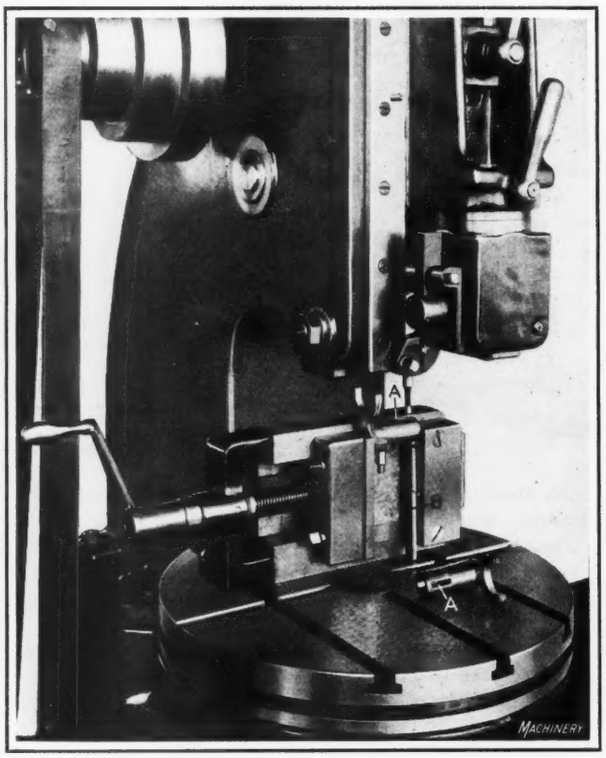


Fig. 3. Use of a Vertical Shaper for squaring up the Ends of a Milled Slot

Shaping a Short Dovetailed Bearing

Another application of the Pratt & Whitney vertical shaper in handling a production job is illustrated in Fig. 2, where it will be seen that the work consists of shaping a short dovetailed bearing. At the time when the casting *A* comes to this machine, the lower face has been finish-planed, and this surface is utilized as a locating point in setting up the work which is strapped down to the shaper table. Held in this way, the bottom of the dovetail is elevated sufficiently so that clearance is provided for the tool and chips under the work. The work consists of taking roughing and finishing cuts. The tools are offset as shown at *B*, so that they may be used in a ram that reciprocates vertically.

Shaping Plane and Cylindrical Surfaces

The universal shaper and milling machine built by the Cochrane-Bly Co., Rochester, N. Y., was primarily designed for use in tool-rooms, but machines of this type are demonstrating their adaptability for production work. A case in point is shown in Fig. 4, which illustrates a machine of this type engaged in shaping the outer surface of the swivel worm bearing for use on the Cochrane-Bly rotary table. As a clear understanding of the form of this piece is important, in order to grasp the possibilities of the combination of a vertical shaping machine and a rotary work-holding table in generating cylindrical surfaces and planes tangent to such surfaces, an illustration showing three views of the swivel worm bearing is presented in Fig. 6. It will be seen that there are two plane surfaces *A* which are tangent to the semi-cylindrical surface *B* at each side. In shaping this piece, the casting is mounted on the rotary table with a bolt extending through the hole *C* to secure the work in the desired position, the location of this bolt corresponding to the axis of rotation of the rotary table.

The method of procedure is to generate one of the plane surfaces by using the straight traverse movement of the table in conjunction with the reciprocating action of the vertical ram. When the tool point reaches the position of tangency of the plane and semi-cylindrical surface, longitudinal traverse of the table is discontinued and the rotary feed of the table is employed. This provides for generating the semi-cylindrical surface, and when the tool point reaches the position where the plane surface becomes tangent to the cylindrical surface at the opposite side of the work, longitudinal traverse movement of the table is substituted for the

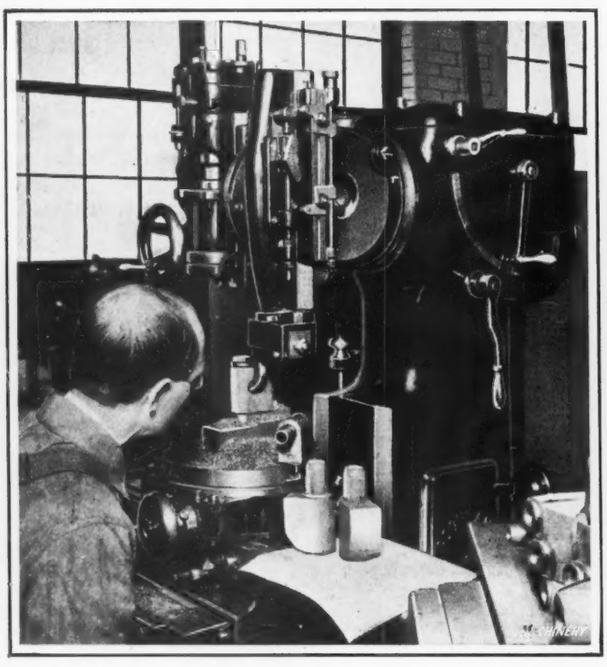


Fig. 4. Utilizing Straight-line and Rotary Feed Movements for shaping an Irregular Piece

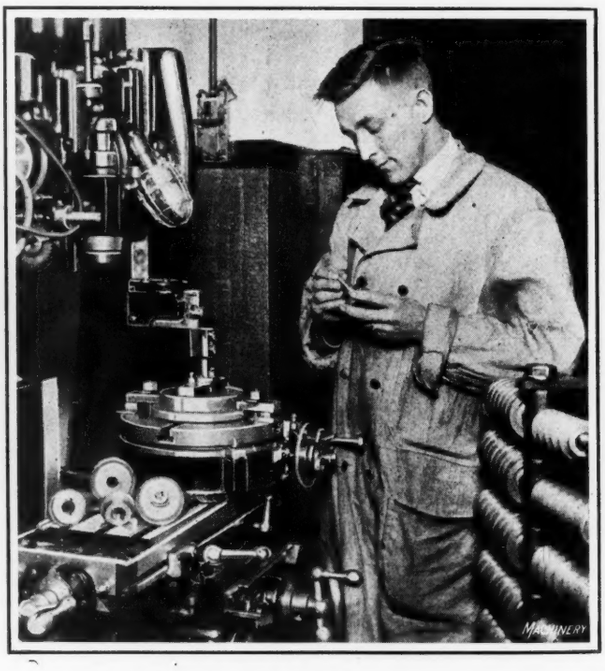


Fig. 5. Cutting Three Equally Spaced Spline Grooves on the Vertical Die Shaper

rotary feed movement, to generate the second flat side of the work. A high degree of accuracy is required on these pieces, it being especially necessary to maintain the cylindrical surface concentric with the bore *C*. With this method of machining, practically all hand work is eliminated, and the entire job is completed at a single setting within limits of ± 0.001 inch.

Shaping Three Keyways in a Tapered Bore

At the Gleason Works, Rochester, N. Y., there were 10,000 chrome-nickel steel gears in each of which it was required to cut three keyways in a bore tapering 2.4 inches per foot. The form of the work and its dimensions are shown in Fig. 7, where it will be noticed that the small end of the tapered hole is only 0.488 inch in diameter. The cutting of these keyways is a difficult job, as they are required to be parallel with the bore and all dimensions must be held within limits of ± 0.001 inch.

After giving this problem careful consideration, the planning department of the Gleason Works decided to put the job on a Cochrane-Bly universal shaper, as shown in Fig. 5. A special holder was provided to clamp the gear blank to the indexing table, and the shaper head was inclined at the proper angle for the taper of the bore, by the micrometer adjustment. With this equipment it was possible to cut the keyways with satisfactory results at the rate of six gears per hour, which corresponds to a cutting time of 3.33 minutes per keyway.

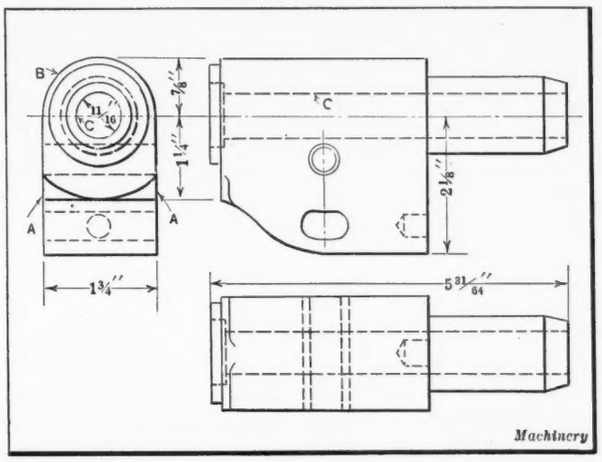


Fig. 6. Design of Piece to be shaped on the Machine shown in Fig. 4

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EARLY DISCOVERY OF THE RECALESCENCE POINT IN HEATING STEEL

In a publication issued in 1778 by one of the industrial associations of that time in Sweden, there is an article on the hardening of steel, written by J. F. Angerstein, in which the author mentions that he has observed a means whereby the correct hardening temperature for steel may be accurately determined. He points out that at the right hardening temperature there is a sudden shadow or lack of brightness in the object being heated. This shadow is evidently caused by the temperature reduction which takes place when the steel passes the recalescence point. It was not possible for the early observer to understand the exact reason for the loss of brightness or shadow in the heated steel, but he had learned that this was the point when the right hardening temperature had been reached, and by observing it he was able to harden at a temperature determined by the same principle as is employed in modern means of determining the recalescence point. It has generally been believed that the earliest observer of this phenomenon was the Russian, Chernoff, who about 1860 called attention to this characteristic of steel when heated. The practical value of these observations was finally clearly laid down by Brinell.

ROTATION OF BALLS IN BALL BEARINGS

On page 330 of December MACHINERY, a description is given of a ball-bearing grinding spindle of unusual construction. It is stated that each ball revolves on its own axis approximately once in every 365 revolutions of the bearing. Is it meant that the balls twist like a bullet once in 365 revolutions, with a motion sometimes called "corkscrewing"?

The test of correct rolling is to assume gear teeth on the contacting surfaces. In fact, we must assume all contacting surfaces having relative motion to be gears with an infinite number of teeth. If a device will not roll correctly with gear teeth on the contacting surfaces, it will not roll at all; in other words, sliding and grinding will take place.

A ball bearing, if assumed to have gear teeth on the contacting surfaces, is simply a planetary transmission. As shown in Fig. 1 in the article referred to, each ball would make about 1.3 revolutions about its axis for each revolution of the bearing. This is decidedly different from one revolution for 365 revolutions of the bearing. Actually, at 10,000 revolutions per minute of the bearing, each ball would make approximately 13,000 revolutions on its axis.

Aurora, Ind. L. LANGHAAR
Vice-president, Langhaar Ball Bearing Co.

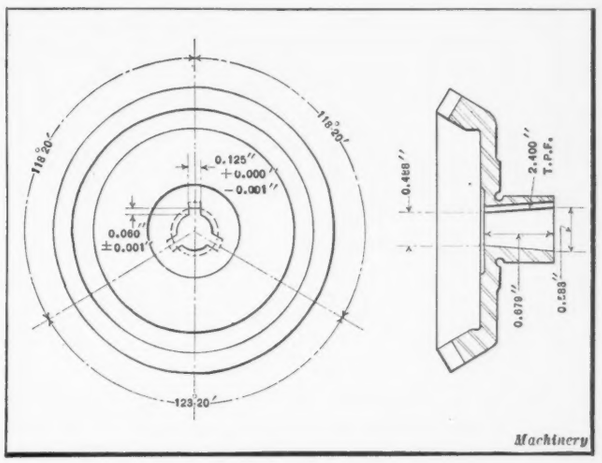


Fig. 7. Design of Work to be shaped on the Machine shown in Fig. 5

Reply by the Ex-Cell-O Tool & Mfg. Co.

We believe that your correspondent does not understand the construction of our ball races. In the second paragraph of the article, beginning with the second sentence, the difference in angle is explained. Perhaps a better way of expressing the true condition would be as follows:

In this design the point of contact of a ball on one race is farther from the axis of rotation than on the other, and this condition causes the balls to revolve about their own axes at right angles to the axis of the device, as well as in the same direction as the device. The number of right-angle revolutions is dependent upon two factors—the diameter of the balls and the difference in the angles of the race.

The ball must necessarily revolve about its own axis in the same direction as the race, and this condition is the same as in a planetary transmission. However, we cannot understand how the figures given in the preceding are arrived at, inasmuch as the number of revolutions of the ball about its own axis in the same direction of rotation as that of the race is dependent upon the size of the balls used and the diameter of the races.

Detroit, Mich. N. A. WOODWORTH
Manager, Ex-Cell-O Tool & Mfg. Co.

* * *

It is reported that the Ford Motor Co. is planning to install the largest steel-melting furnace ever built. The capacity will be 9000 kva., which is said to be three times the size of any previously installed furnace.

Exports of Metal-working Machinery before and after the War

A REVIEW of the foreign markets for American machinery shows that as far back as 1910, the United States exported more machine tools and metal-working machinery than any other country in the world, nearly $6,000,000 worth being exported during the twelve months ended June 30, 1910. These exports have gained steadily since that time up to the present period of depression. The decrease during the last two years is a natural result of the general industrial depression; but in comparison with the pre-war figures, these exports show a decided advance, the demand in all countries of the world for American machinery having increased considerably, particularly in non-European markets. During the twelve months ended June 30, 1921, the United States exported machine tools and metal-working machinery amounting approximately to $34,000,000 as compared with a total of $14,000,000 for a similar period ended June 30, 1914. This gain was not actually as great as the figures would seem to indicate, because the prices of metal-working machinery of all kinds had increased approximately 100 per cent since 1914; yet, there is a definite gain. The exports amounted to $58,000,000 in 1919, and $44,000,000, in 1920. With the return to normal conditions, the exports in this line are likely to be substantially above the pre-war level.

TABLE 1. VALUE OF EXPORTS TO JAPAN, CHINA, INDIA AND DUTCH EAST INDIES FOR 1914 AND 1920

Countries	1914	1920
Japan	$120,166	$4,250,583
China	17,668	932,351
India	17,953	1,374,068
Dutch East Indies	20,216	326,086

Machinery

The Market in Asia

Asia presents the most interesting feature in the expansion of our foreign markets in metal-working machinery, the demand for the American product there having increased steadily since before the war, rising from about $207,000 for the year ended June 30, 1914 to over $7,000,000 for the calendar year 1920, a gain of over 3300 per cent in less than seven years. The rapid industrialization of Asia, particularly of such countries as Japan, China, India, and the Dutch East Indies, has helped materially to increase the Asiatic market for machine tools and metal-working machinery. Of these countries, the greatest gain is found in India, where the market for American machines increased nearly 7600 per cent during the period mentioned. Table 1 gives the value of machine tools and metal-working machinery exported to these countries for the year ended June 30, 1914, as compared with the calendar year 1920.

American Machines in Great Britain

For the fiscal year ended June 30, 1914, Great Britain imported $376,000 worth of machine tools from the United States, or 88 per cent of her total imports in this line. For the calendar year 1920 American exports of machine tools to Great Britain totaled $6,000,000. In 1914 the total value of machine tools and metal-working machinery exported to England was approximately $3,000,000 as compared with more than $10,000,000 in 1920. The extensive use of American machines in Great Britain during the war no doubt did much to establish a permanent market in that country for many types of American tools.

Exports to France and Germany

In France a similar increase has been manifested. During normal times, previous to the war, there was a rise from $307,000 in 1909 to a total of nearly $2,000,000 worth of machine tools and metal-working machinery for the fiscal year ended June 30, 1914. The market, of course, was greatly inflated during the war, rising to a peak of $29,000,000 in 1917, and receding to $7,500,000 for the calendar year 1920. This figure, however, is much larger than the immediate pre-war total of $2,000,000.

The German market presents an entirely different situation. Previous to the war, for the twelve months ended June 30, 1914, Germany imported over $2,000,000 worth of machine tools and metal-working machinery from the United States. At that time the German market for American machines was second only to that of Great Britain. Since the war, however, the market has been very poor, reaching a total of only $144,000 for 1920.

Table 2 gives the value of exports of machine tools and metal-working machinery from the United States for the years 1914 and 1920, together with the value of the exports to the leading European countries and Asia. Attention is called to the fact that the per cent of increase relates to the total value of the exports and not to the increase in tonnage. As the price of machine tools has practically doubled during the last seven years, the number of machines exported has not increased in so large a proportion as their value.

TABLE 2. VALUE OF EXPORTS TO ENGLAND, FRANCE, GERMANY AND ASIA FOR 1914 AND 1920

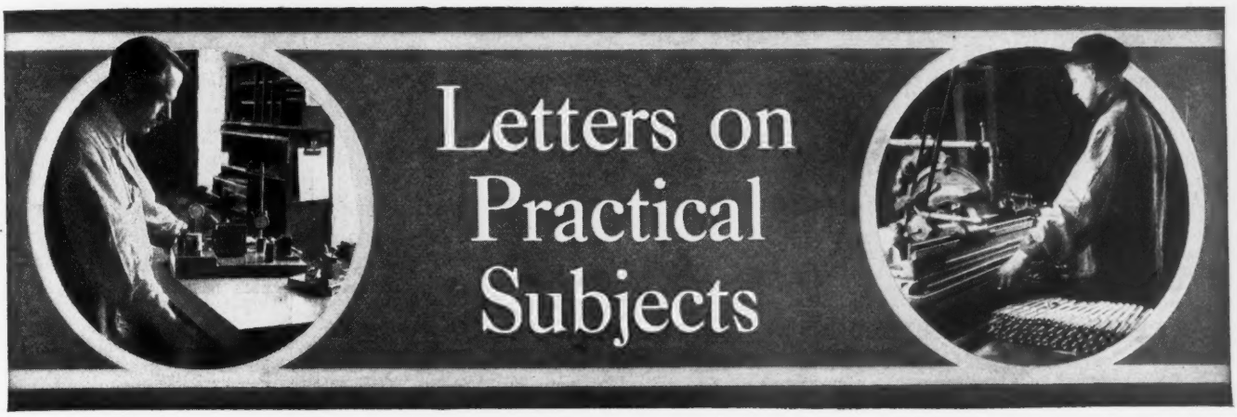
	1914	1920	Per Cent Increase
Total Exports	$14,011,359	$44,312,233	215
Exports to England	2,988,684	10,760,957	260
Exports to France	1,771,525	7,595,733	329
Exports to Germany	2,167,240	144,192	...
Exports to Asia	207,389	7,181,435	3369

Machinery

Comparison of Machines Manufactured and Exported

In 1919 the value of the machine tools and metal-working machinery manufactured in the United States was $212,000,000. Of this amount $58,500,000 worth or 27½ per cent were exported to the various countries of the world, England absorbing $15,000,000 worth, France $15,000,000 worth, and Asia as a whole, $8,500,000 worth of these machines. In comparison with the pre-war figures, however, this percentage shows practically no change. During the twelve months ended June 30, 1914, the manufactures of machine tools and metal-working machinery totaled $48,000,000, the exports amounting to $14,000,000 or 29 per cent of the machines manufactured.

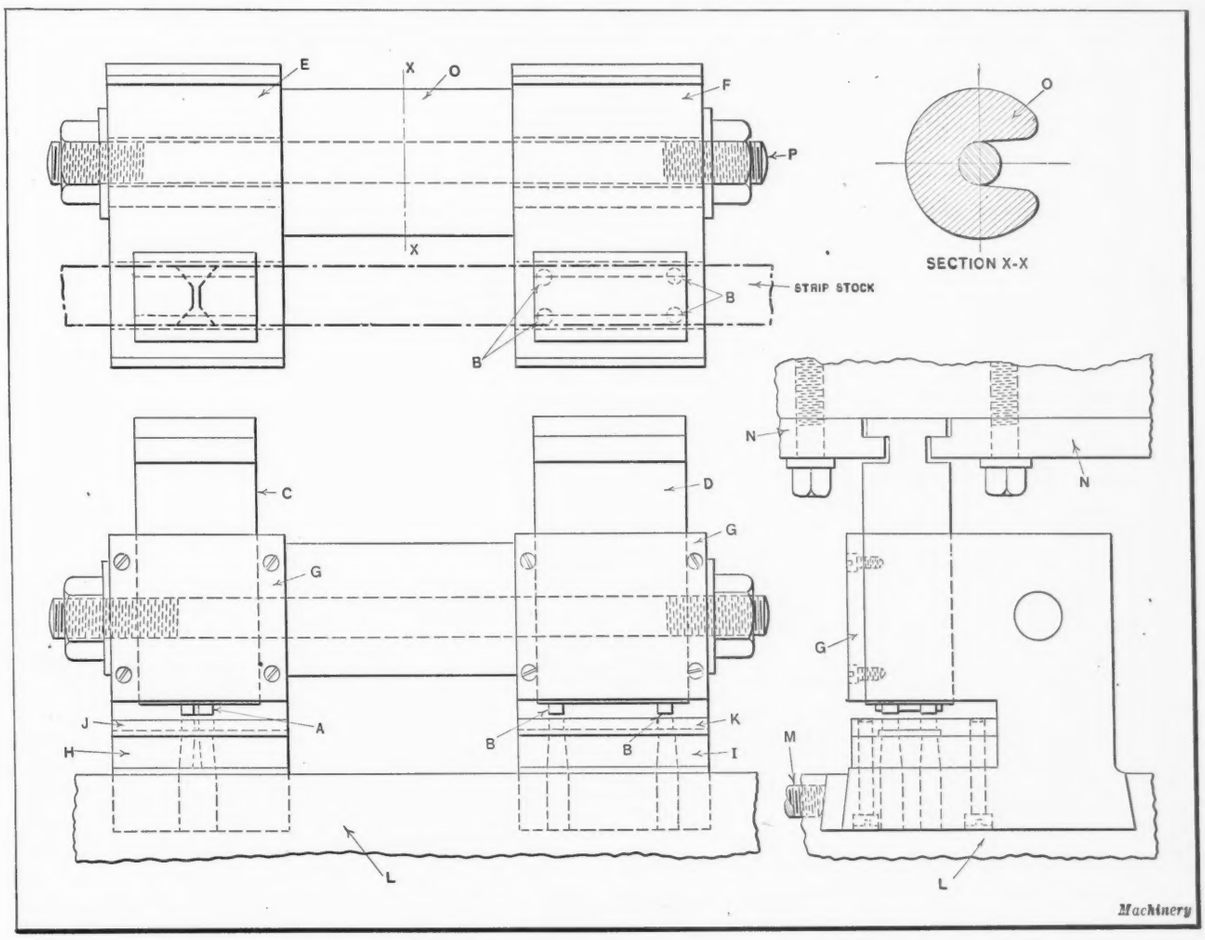
The figures quoted show that, even allowing for the difference in prices in 1914 and 1920, the exports in the latter year were so much greater that it would not be reasonable to expect them to remain at those figures continuously. The exports of 1920 may be greatly reduced, and yet our metal-working machinery exports will exceed the pre-war exports.



DIES OF UNIT CONSTRUCTION FOR GANG PUNCHING

Where adaptable, dies of unit construction, such as the one shown, will be found particularly satisfactory from the point of view of economy. In many cases it is possible to build up a die by combining a number of die units, thereby avoiding the necessity of making a complete die or sections of a die. The units of sub-press dies formed in this way are, of course, separable. Each unit contains punches for one group of holes or perforations. It is therefore an easy matter to arrange the units for the production of parts made by piercing, perforating, and cutting off strip stock. The illustration shows two units set up for the production of perforated straps from the strip stock indicated by dot-and-dash lines. The die unit at the right contains the punches used to pierce a group of four holes in the stock, while the unit at the left is equipped to cut off the stock to the required length. It will be noted that the cutting-off punch *A* is designed to cut the corners of the stock at an angle of about 45 degrees.

The cutting-off punch *A* and the perforating punches *B* are held in blocks *C* and *D*, respectively, which slide in cast-iron holders *E* and *F*, being held in place by plates *G*. The die members are shown at *H* and *I*, and the stripper plates at *J* and *K*. The material being worked is fed through the slot cut in the stripper plates. The entire assembly, consisting of the punch-holder, holder slide-block, die, and stripper plate, is slid into a die base *L*, in which it is clamped by means of screws *M* while punch-holding slides *C* and *D* are clamped to the ram of the press by strips *N*. Thus it will be seen that the usual up-and-down movement of the press causes the four punches in holder *D* to perforate the stock while the cutting-off punch in holder *C* cuts off the previously punched stock. A pin or block (not shown) at the left of die *H* serves as a stop for determining



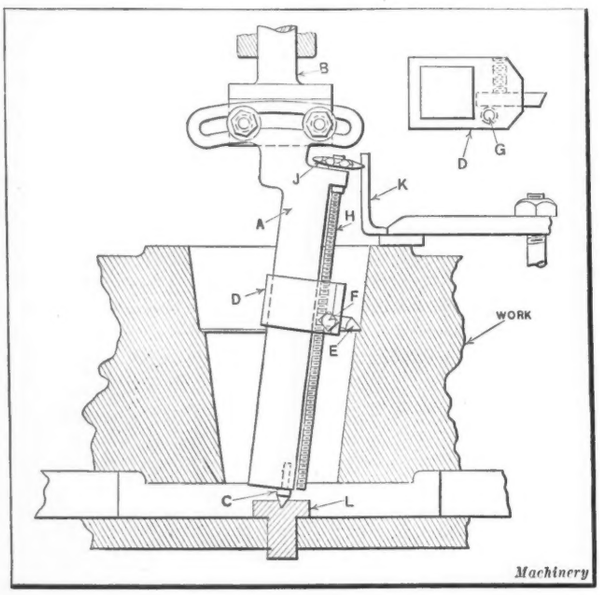
Gang Punch of Unit Construction for perforating and cutting off Strip Stock

the length to which the stock is to be cut. A spacer *O*, placed between blocks *E* and *F*, locates the dies the proper distance apart. A screw *P* with nuts at each end completes the equipment. Instead of the two units shown in the illustration, as many as six or more may be used with spacers of the proper length placed between them. It is obvious that a great many set-ups can be provided by this arrangement. One of the chief advantages of the unit construction is that work of many lengths having the same general lay-out of holes or openings can be produced by merely changing the spacing blocks *O*.

F. SERVER

TAPER BORING ATTACHMENT FOR DRILLING MACHINE

The taper boring tool described in the following can be used on a drilling machine or on a horizontal boring mill. The swiveling action of the tool-carrying bar *A*, which can be clamped rigidly to the taper shank *B*, held in the drilling



Taper Boring Attachment for Drilling Machine

machine spindle, permits a wide range of adjustment, so that the tool can be used for boring cylindrical holes as well as holes having steep tapers. Holes in large castings, such as side frames, etc., and jobs too large to be bored on the lathe, as well as rush jobs for which extra machines must be rigged up can be handled with this tool.

As will be apparent from the illustration, the tool is simple and designed to secure accurate results. The head of the tapered shank *B* is planed off square with the center line of the shank, in order to form a clamping surface for the head of bar *A*. The tool-bar is made from an iron casting of the form shown. It is shaped or planed square and true, and is drilled at the bottom to receive a small center *C*. This center must be exactly in the center of rotation when the tool-carrying bar is set vertical.

A small carriage *D*, which is slotted to hold a square tool bit *E*, is mounted on the squared end of bar *A*. The tool bit is held in position by a set-screw *F*. The carriage is made of cast iron or steel, and must be a close sliding fit on bar *A*. A hole *G* in the carriage, at the rear of the tool, which is shown in the view in the upper right-hand corner of the illustration, is tapped to fit the feed-screw *H*. This feed-screw extends down from the top bearing, and carries at its top end a star-wheel *J*. The star-wheel is operated by setting a finger *K* so as to rotate it one space every revolution of the tool. If a heavy feed is desired, as when using a square-nosed finishing tool, two fingers may be employed instead of one.

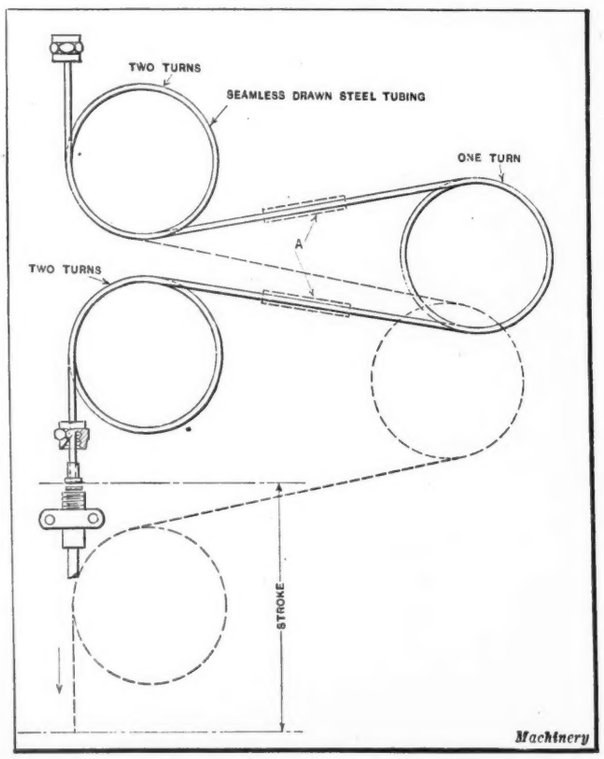
When using this tool, the center *C* rests and rotates in a hardened female center *L*, set into a tight fitting hole in the drilling machine table. The work is centered by clamping a wire finger or pointer to the tool-bar and rotating it around the outside of the job, or over a line scribed on the work. When used on a horizontal boring mill a suitable center hole in a block or clamp can be used in place of center *L*. Care should be taken in making the tool to have the forward edge of the tool slot exactly on the center line, and also to grind the tools accordingly; otherwise the taper will not be true. Most tapers are given on drawings as inches per foot, or in degrees, in which case a bevel protractor is used to set the angle of the tool.

Allentown, Pa. JOE V. ROMIG

SPRING PIPE CONNECTION FOR HYDRAULIC PRESSES

The spring pipe connection here illustrated was designed by the writer for use on a hydraulic press in place of a telescope pipe. The telescope pipe connection was employed to supply the water pressure required to move the table back and forth. The rapid wear on the packing, the tendency for the telescope pipe to buckle under high pressure, and the frequent breaking at the point where it was screwed into the bracket made this type of connection a source of annoyance.

The breaking and buckling was overcome by using a telescope pipe of larger size, but the packing still had to be frequently renewed. With the large pipe it was necessary to use throttle washers in the fittings to reduce the amount of water delivered, so as to decrease the speed of the back-



Spring Pipe Connection for Hydraulic Presses

and-forth movement of the table. Finding that a very small opening in the throttle washers gave the desired result, it occurred to the writer that a small size spring pipe connection of seamless drawn steel tubing might be employed in place of the telescope pipe. Accordingly, some tubing of suitable size was obtained, and experiments were made which resulted in the development of the connection shown.

The seamless drawn steel tubing, coiled and bent to the shape indicated, was found to be capable of withstanding

the fluctuating pressures and consequent vibration of the hydraulic press and accumulator pipe-line system, and to be capable of being sprung back and forth from the position shown by the full lines to that indicated by the dotted lines. This arrangement gave little or no trouble.

It will be noted that two turns are made in the coils next to the unions and one in the middle coil. It was found that one coil next to the unions would not withstand the strain of opening and closing, combined with that produced by vibration. An extra turn, however, overcame this difficulty and eliminated breakage at the unions. The complete set of coils in the pipe seemed to float, and did not vibrate as might have been expected. The satisfactory action of the connection is due chiefly to the fact that the coils can move in all directions. This device or a similar one could probably be used to advantage on many types of machines where a flexible pipe connection that will not whip when subject to fluctuating pressures is required. Unions attached to the ends of the coil tube make them readily detachable in case of breakage, so that a renewal can be made quickly, but this is seldom necessary. If it is difficult to obtain seamless steel tubing of sufficient length to make a complete coil, two or three lengths of tubing may be used. The joints should be made as indicated by the dotted lines at *A*.

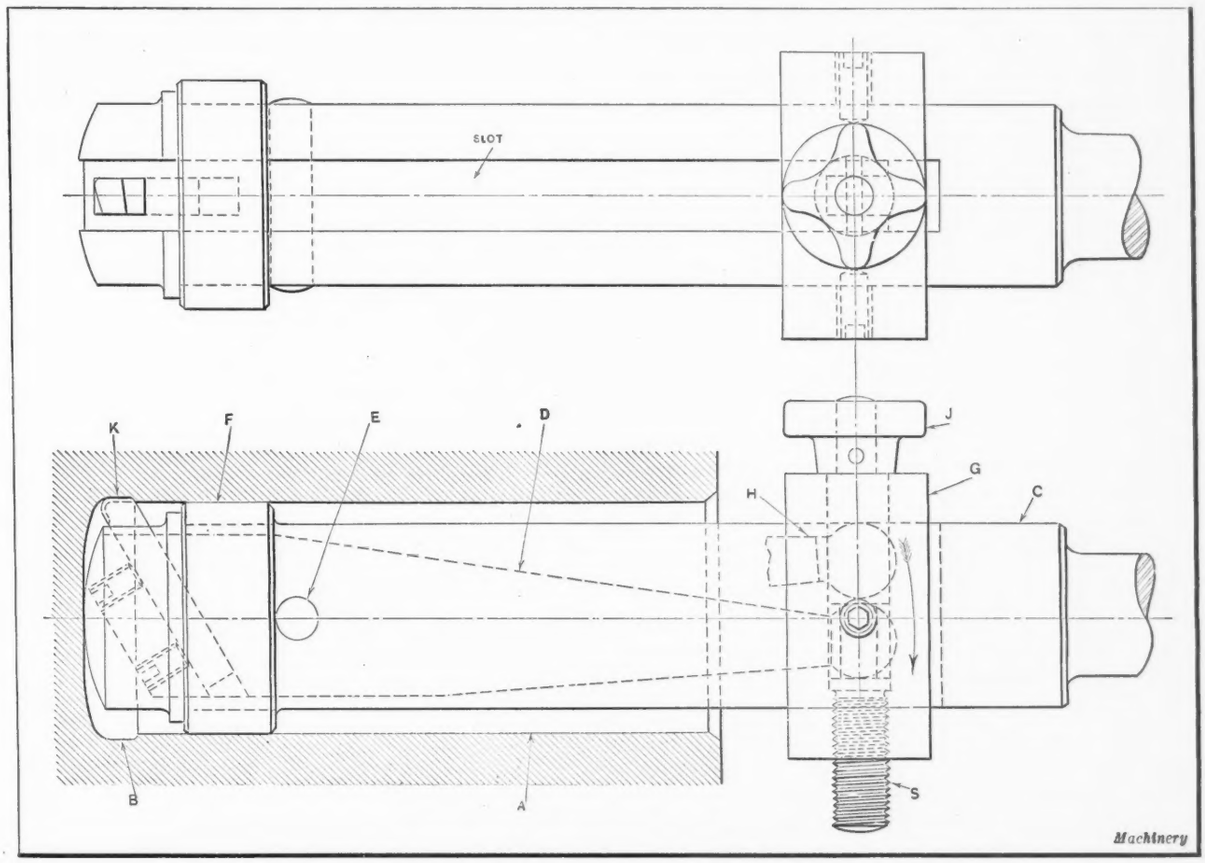
Lyells, Va. W. R. WARD

DEEP-HOLE RELIEVING TOOL

The tool shown herewith was designed for cutting a recess *B* in the combustion chamber of an automobile engine cylinder *A*. This recess is made to provide a clearance for the grinding wheel when finish-grinding the bore. As the cylinder block for which this tool was designed had four bores and was 25 inches long, it was found impractical to perform the recessing operations on a lathe or boring machine. It will be noted, however, that only one bore of the cylinder block is shown in the illustration. The depth of the recess *B* is 1/16 inch, and its length is ½ inch.

The tool is provided with a heavy shank *C* which has a taper at one end that fits the drilling machine spindle. A slot is machined at the opposite end of the shank for the tool-arm *D* which is pivoted on pin *E*. The ring *F*, pressed on the shank, is made a running fit in the cylinder bore, and provides a means of guiding the end of the tool. This ring also prevents the split ends of shank *C* from spreading. The ring *G* is pinned to the shank, and carries the feeding mechanism of the tool-arm.

The tool-arm must be adjusted to the position indicated by the dotted lines at *H* before it can be lowered into the cylinder bore. When the tool-carrying end of the shank rests on the head of the combustion chamber, the machine is started. The knob *J*, pinned to screw *S*, is turned at intervals in order to feed the right-hand end of tool-arm *D* in the direction indicated by the arrow. Cutter *K* is thus fed outward a sufficient distance to cut the recess to the required depth. The knob *J*, coming in contact with ring *G*, serves as a stop for determining the depth of the cut. When the recess *B* has been cut to depth, the machine is stopped, after which screw *S* is turned back by means of knob *J* until cutter *K* is drawn back into the shank, thus permitting the tool to be removed and inserted in the bore of the next cylinder. This tool has proved accurate, can be operated rapidly, and eliminates considerable heavy lifting and setting-up work.



Tool for cutting a Recess in the Combustion Chamber of an Automobile Engine Cylinder

Pittsburg, Pa. WILLIAM OWEN

A COUNTERSHAFT TEMPLET

The installation of a heavy overhead countershaft which is in any way complicated requires the personal supervision of a foreman or master millwright. Some machines have several pairs of hangers, or, several countershafts, which must be in close alignment with each other and with the machine in order to function properly.

In some factories the plan has been adopted of laying out beforehand, a temporary wooden templet of any counter-

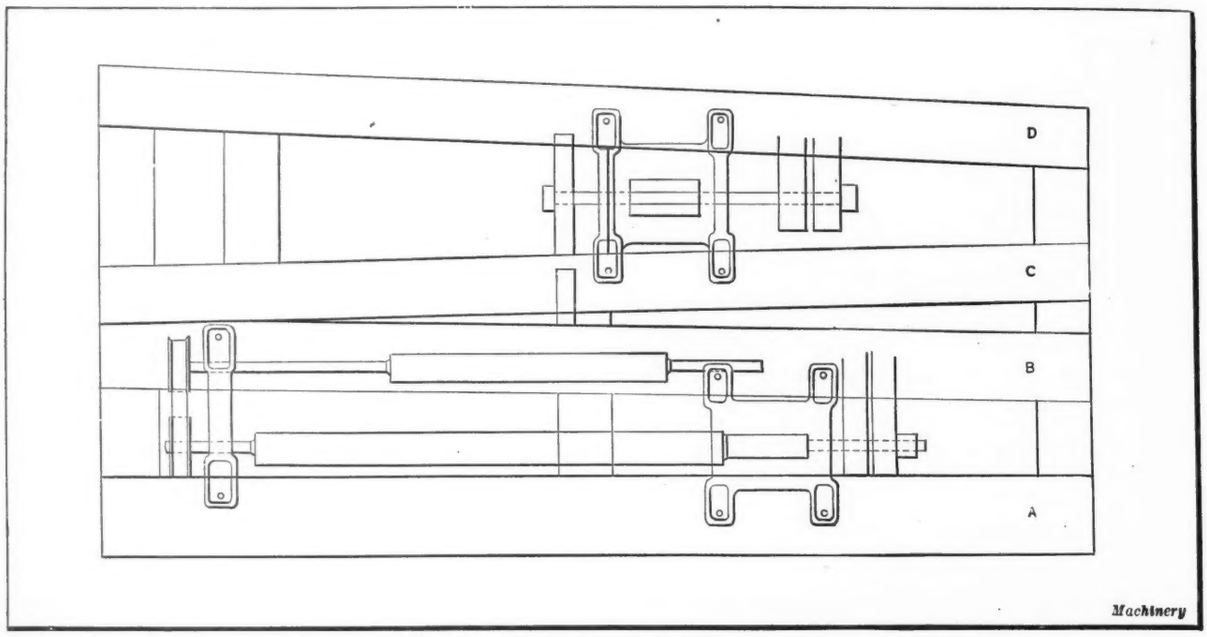


Fig. 1. Ceiling Plan of Countershaft Equipment installed by the Aid of the Templet shown in Fig. 2

shaft which promises to give trouble. It has been found that such a templet enables the workman to put the countershafts in their proper places without the constant supervision of the foreman, and thus enables the latter to attend to work elsewhere in the factory.

In Fig. 1 is shown a ceiling plan view of the overhead countershaft equipment of a grinding machine. The wheel-speed countershaft with its hangers, and the work-drive drum and the table-drive drum with their hangers and countershafts are shown. The positions of the stringers on the ceiling, as obtained from the dimensions given on the erecting print of the machine are indicated at *A*, *B*, *C* and *D*. The master mechanic's templet, Fig. 2, which is made up from the dimensions given on the erecting print is used by the workmen as a guide in placing the stringers in their proper positions on the ceiling.

The templet should be made from ⅞- or 1-inch stock. When in use, it is placed on the ceiling beams, or ceiling-insert plates in a cement constructed building. The straight-edge *E* of the templet is aligned with the main lineshaft and an outline drawn on the beams or ceiling to give the location of the stringers. The templet is next removed and the stringers bolted in place, after which it is clamped in position on the stringers to locate the holes for the hanger bolts. These holes, three of which are shown at *F*, *G* and *H*, are, of course, accurately laid out and drilled, in the templet, according to the dimensions shown in Fig. 2. R. J. S.

* * *

It is stated in a recent Commerce Report that about 62.7 per cent of the world's shipbuilding is being done in British shipyards. Of this amount nearly all is constructed in the United Kingdom; yet there is a serious depression in the shipbuilding industry. Of the 3,500,000 tons of shipping now building, 2,750,000 tons are almost completed. Only about four months full time work is in sight.

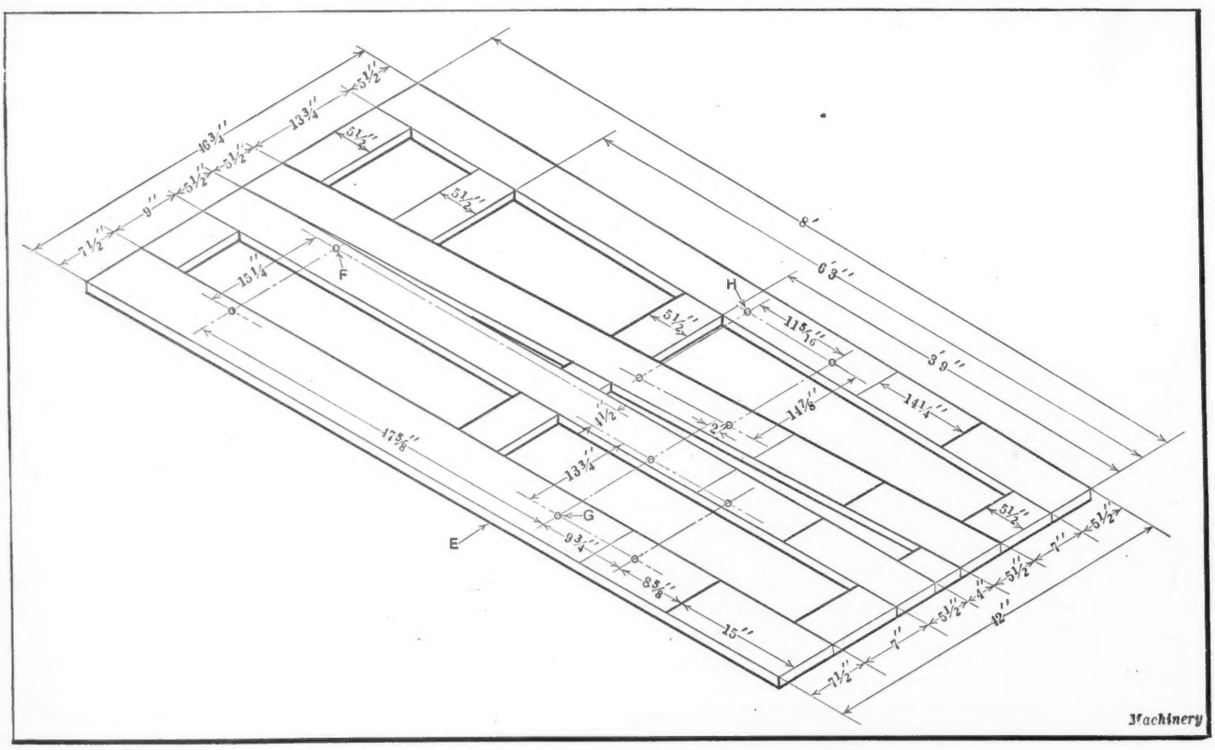


Fig. 2. Details of Templet used in putting up Countershaft shown in Fig. 1

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DRAWING A DEEP WIDE-FLANGED SHELL

J. E. J.—I want to draw a flanged cup from 1/16-inch sheet steel, 1½ inches deep, 1 inch in diameter, and having a 3½-inch diameter across the flange. What is the best way to make the dies, and how many operations are necessary?

A.—Specific information regarding drawing die work is difficult to furnish, because no matter what procedure is recommended, the practice is dependent on the equipment with which it is intended to do the job. Press work is always more or less of an experimental proposition. In the present case, the problem is a difficult one, because in addition to the deep cup to be drawn there is a very wide flange. It will probably require four operations to produce the shell. As regards the design of the dies, the information contained in the article published on page 964 of June 1920, MACHINERY will prove of value. The stock used is much heavier than mentioned in the present case, but the design of the dies will be helpful in designing similar ones.

DETERMINING DIAMETER OF DISK TANGENT TO THREE OTHER DISKS

G. R. P.—Can someone give me a formula for finding the diameter of disk X in Fig. 1, when the diameters of the other disks and the distances between their respective centers are known?

ANSWERED BY W. W. JOHNSON, CLEVELAND, OHIO

A.—This is the problem of four tangent circles. It is a special case in which the diameters of two of the circles are equal, but it can be solved by the general solution which is as follows: Referring to Fig. 2, let L, M, and N be the centers of the three given circles whose radii are a, b, and c, respectively, and let $MN = x$, $LN = y$ and $LM = z$; then find r. An equation of the second degree can be obtained as follows:

Let $LO = p$, $MO = q$, $NO = s$, and angle $LOM = \theta$, angle $MON = \phi$, and angle $NOL = \alpha$.

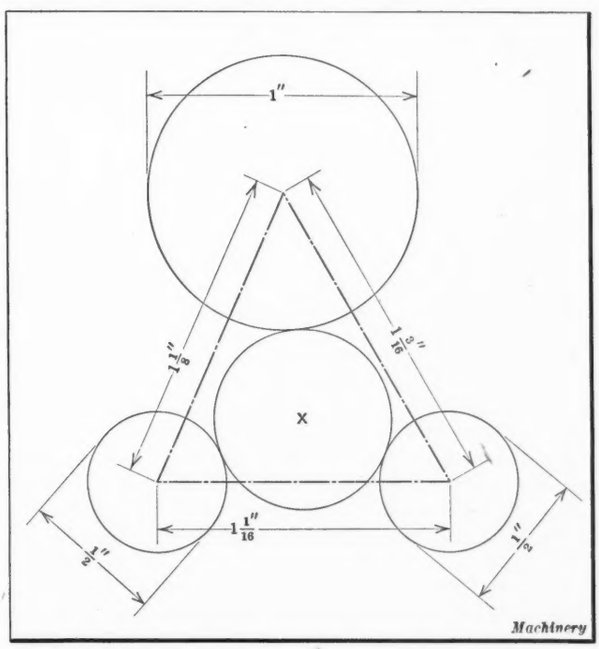


Fig. 1. Diagram illustrating Problem to find Diameter of Disk X

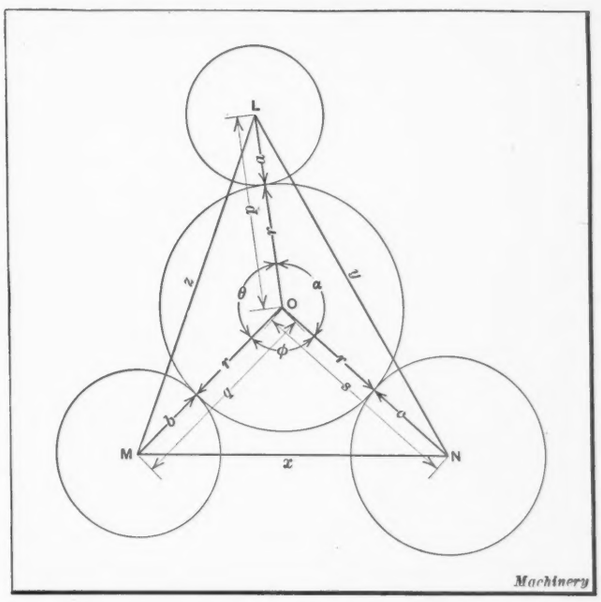


Fig. 2. Diagram used in Solution of Problem presented in Fig. 1

Then

$$\theta + \phi + \alpha = 360 \text{ degrees}$$

$$\theta = 360 \text{ degrees} - (\phi + \alpha)$$

$$\text{Cos } \theta = \cos(\phi + \alpha) = \cos\phi \cos\alpha - \sin\phi \sin\alpha$$

$$\text{Cos } \theta - \cos\phi \cos\alpha = -\sin\phi \sin\alpha$$

Squaring both sides,

$$\text{Cos}^2\theta - 2\cos\theta\cos\phi\cos\alpha + \cos^2\phi\cos^2\alpha = \sin^2\phi\sin^2\alpha$$

$$= (1 - \cos^2\phi)(1 - \cos^2\alpha)$$

$$= 1 - \cos^2\phi - \cos^2\alpha + \cos^2\phi\cos^2\alpha$$

Hence,

$$\text{Cos}^2\theta + \cos^2\phi + \cos^2\alpha - 2\cos\theta\cos\phi\cos\alpha = 1 \quad (1)$$

From the cosine formulas in trigonometry:

$$\text{Cos } \theta = \frac{p^2 + q^2 - z^2}{2pq} = 1 + \frac{(p-q)^2 - z^2}{2pq}$$

$$\text{Cos } \phi = \frac{q^2 + s^2 - x^2}{2qs} = 1 + \frac{(q-s)^2 - x^2}{2qs}$$

$$\text{Cos } \alpha = \frac{s^2 + p^2 - y^2}{2sp} = 1 + \frac{(s-p)^2 - y^2}{2sp}$$

Put, in the numerators, $p = r + a$, $q = r + b$, and $s = r + c$, and let A, B, and C represent certain expressions in the results; then,

$$1 + \frac{(p-q)^2 - z^2}{2pq} = 1 + \frac{(a-b)^2 - z^2}{2pq} = 1 + \frac{A}{2pq}$$

$$1 + \frac{(q-s)^2 - x^2}{2qs} = 1 + \frac{(b-c)^2 - x^2}{2qs} = 1 + \frac{B}{2qs}$$

$$1 + \frac{(s-p)^2 - y^2}{2sp} = 1 + \frac{(c-a)^2 - y^2}{2sp} = 1 + \frac{C}{2sp}$$

By substituting these values in Equation (1), performing the operations indicated, clearing of fractions and cancelling, the following equation is obtained:

$$A^2s^2 + B^2p^2 + C^2q^2 - 2ABsp - 2BCpq - 2CAqs - ABC = 0 \quad (2)$$

Putting $p = r + a$, $q = r + b$, and $s = r + c$, in Equation (2), performing the operations indicated, and combining,

$r^2 [A^2 + B^2 + C^2 - 2AB - 2BC - 2CA] + 2r[A^2c + B^2a + C^2b - AB(a + c) - BC(a + b) - CA(b + c)] + [A^2c^2 + B^2a^2 + C^2b^2 - 2ABca - 2BCab - 2CAbc - ABC] = 0$ (3)

This is a general quadratic equation, from which two values for r are always found; one applies to the circle making internal contact with all three circles, and the other to the circle making external contact with all three circles.

From Fig. 1, $a = \frac{1}{2}$ inch, $b = \frac{1}{4}$ inch, $c = \frac{1}{4}$ inch, $x = 1\ 1/16$ inches, $y = 1\ 3/16$ inches, and $z = 1\frac{1}{8}$ inches.

For convenience, reduce all values to sixteenths and use only the numerators in carrying out the calculations; this is the same as multiplying the roots of Equation (3) by 16. Then, $a = 8$ inches, $b = 4$ inches, $c = 4$ inches, $x = 17$ inches, $y = 19$ inches, and $z = 18$ inches; and

$$A = (a - b)^2 - z^2 = -308$$
$$B = (b - c)^2 - x^2 = -289$$
$$C = (c - a)^2 - y^2 = -345$$

Inserting these values in Equation (3), and solving, the different coefficients can be found as follows:

Coefficient of $r^2 = A^2 + B^2 + C^2 - 2AB - 2BC - 2CA$
$= -292{,}544$

Coefficient of $2r = A^2c + B^2a + C^2b - AB(a + c) - BC(a + b) - CA(b + c)$
$= -1{,}590{,}960$

Absolute term $= A^2c^2 + B^2a^2 + C^2b^2 - 2ABca - 2BCab - 2CAbc - ABC = +23{,}998{,}500$

This gives the quadratic equation,

$$292{,}544r^2 + 2(1{,}590{,}960)r - 23{,}998{,}500 = 0$$

Dividing by 4, this equation reduces to:

$$73{,}136r^2 + 2(397{,}740)r - 5{,}999{,}625 = 0$$

Solving for r,

$$r = \frac{-397{,}740 \pm \sqrt{397{,}740^2 + (73{,}136 \times 5{,}999{,}625)}}{73{,}136}$$

Using this equation with the plus sign before the radical to find the radius of a circle making external contact with all three circles,

$$r = 5.1262$$

Since the roots of the equation were multiplied by 16, divide the value of r by this number. Thus, $r = 0.3204$. Therefore, the radius of the disk X in Fig. 1 is 0.3204 inch, and the diameter is twice that or 0.6408 inch.

STRAIGHT PIPE THREADS

C. H. B.—Has any standard been adopted for straight pipe threads, and where are such threads generally used?

A.—The following information conforms to the American Standard pipe threads and to the standard approved by the National Screw Thread Commission:

The straight pipe thread has the American or Briggs tapered pipe thread in regard to pitch and depth of thread. The basic pitch diameter for straight pipe threads equals the pitch diameter at the gaging notch of the tapered plug gage. In the report of the National Screw Thread Commission a table of the pitch diameters for straight pipe threads is given, and other tables relating to different classes of screw threads with recommended allowances, tolerances, etc.

Occasionally it is advisable to use a straight pipe thread of the largest diameter it is possible to cut on a pipe. This thread has also been standardized and is designated in the report mentioned as the "maximum external and minimum internal lock-nut threads." The pitch of this lock-nut thread is the same as the pitch of a standard taper thread of corresponding size. To illustrate the difference between a straight lock-nut thread and the straight pipe thread first referred to, we shall consider the difference between the diameters of the 1-inch normal size. In the case of the straight pipe thread the basic pitch diameter is 1.2386 inch, whereas, in the case of a lock-nut thread, the maximum pitch diameter for an external thread is 1.2603 inch.

The straight external pipe threads are recommended only for special applications, such as long screws and tank nipples. In gaging, the tapered working plug gage for the American or National standard is used, allowing the same tolerance for the notch as for a taper thread.

LENGTH OF QUARTER-TURN BELTS

C. M.—Is there any formula for finding the length of a quarter-turn belt?

ANSWERED BY D. C. PAGE, FITCHBURG MASS.

The standard handbooks do not give formulas making it possible to determine the length of a quarter-turn belt. Several years ago, therefore, the writer developed the formula given below, which has proved satisfactory in practice.

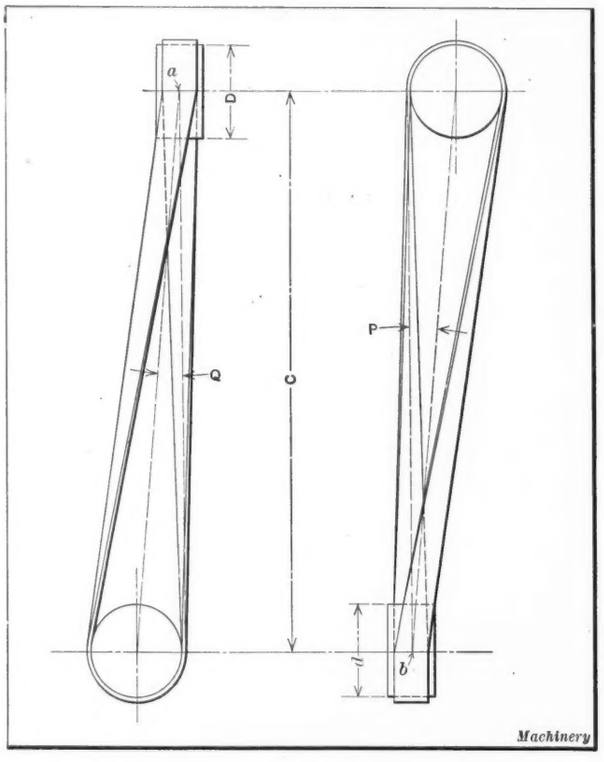


Diagram used in Connection with Formula for finding the Length of Quarter-turn Belts

Referring to the accompanying illustration,

C = distance between centers of pulley shafts;
D = diameter of one pulley;
d = diameter of other pulley;
L = total length of belt;
$\frac{1}{2} D \div C = \cot P$;
$\frac{1}{2} d \div C = \cot Q$.

The values of C, D, d, and L must, of course, be given in the same unit of measurement; that is, they must all be given in inches or feet. Employing the above symbols, the length of the belt is found by the formula

$$L = 2C + \frac{(D + d)\pi}{2} + 0.01746D\ (90 - P) + 0.01746d\ (90 - Q)$$

In working out this formula it was assumed that the belt leaves pulley D at point a, and pulley d at point b, as indicated in the illustration. Actually, however, the belt does not leave the pulleys at exactly these points. For this reason the formula will give a result which is slightly in excess of the exact length. This error, however, is so slight that it does not affect the operation of the belt provided that distance C is always greater than $4(D + d)$. It is obvious that the amount of error decreases as the distance between the pulleys is increased.

Charting the Conditions of Business

By ERNEST F. DuBRUL, General Manager, National Machine Tool Builders' Association, Cincinnati, Ohio

THE chart shown in the accompanying illustration, if kept for each line of product made by a manufacturer, will assist him to control his production in accordance with the actual demands. The great variations in economic cycles occur because of maladjustments between supply and demand, and the greater the number of firms that control their own business in accordance with the demands of the market, the healthier will all business be. In this chart the lines are made up on the cumulative plan. This means that by simply adding the monthly increments of each item, it is possible to measure upward on any vertical line on the chart to obtain the total amount of that item up to date.

The lowest line, which represents consumers' sales, starts at zero. The line which represents shipments starts at the figure above zero that shows the amount of stock of a given machine in the hands of dealers at the beginning of the year. The line marked "Production Finished" starts with the figure plotted above the line marked "Factory Shipments" showing the amount of manufacturers' finished stock on hand at the beginning of the year. The line marked "Production Started" begins with the figure plotted above the line designated "Production Finished" showing the number of units in process but unfinished at the beginning of the year.

The line marked "Net Orders" is a composite line. It starts with the number of machines on unfilled orders at the beginning of the year, plotted above the starting point for the shipment line. It represents the result obtained by deducting the month's cancellations from the new orders received during the month. The order line is the only line that can cross the production or process line. None of the other lines can cross each other, although some might meet and diverge. The order line is also the only line that can show a dip from a previous high point. This would occur only in months during which cancellations were greater than the new orders received. The amount of dip would therefore be the minus quantity resulting from this condition.

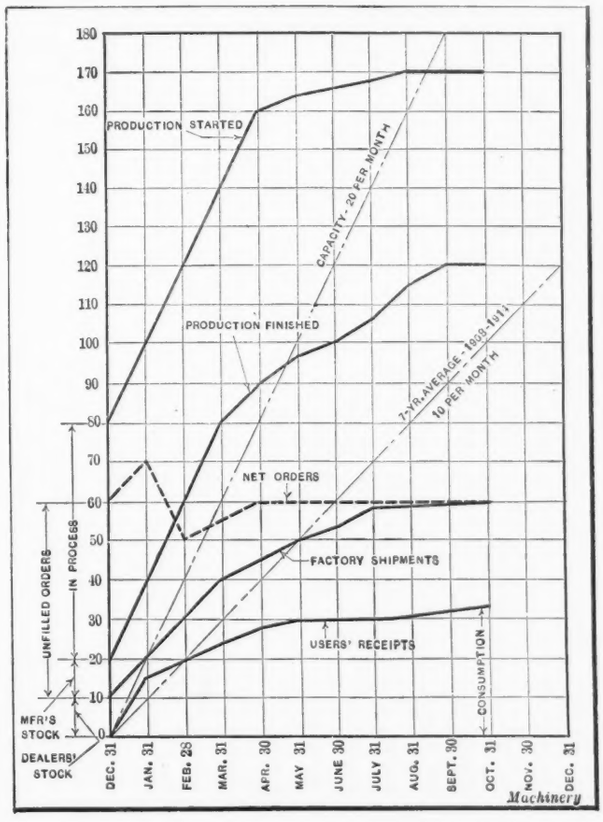


Chart for controlling Production to suit Actual Demands

Two faint dot-and-dash lines are shown running diagonally. The upper one of these represents the accumulated monthly economic capacity of the plant for producing this particular type of article, due account being taken of the quantities of other production which normally accompany the type for which the chart would serve. The second dot-and-dash line represents the monthly average shipments of this particular type, taken over a period covering, say, the pre-war years 1908 to 1914 inclusive, if that would seem to be the highest standard figure that this industry could reasonably expect to count on for some time to come. In this chart these two lines show quite a divergence on their cumulative rise, due to an excess of capacity. The spaces between the various curves on the chart correspond to the balances at the end of the month. The dip in the order curve shows an excess of cancellations during one month.

The chart as drawn shows the situation in the plant of a supposititious manufacturer who has allowed conditions to get out of balance. It will be noted that at the beginning of the year he had ten units of finished product on hand, corresponding to half of one month's capacity. Plotted above this is the amount in process—sixty units, representing three times the capacity, and it may be assumed that the process required three months. His unfilled orders of fifty units were plotted that many points above the dealers' stock. At the beginning of the year these covered not only what he had on hand, but also forty in process. The fact that he had finished product on hand and unfilled orders in addition would indicate that some of these unfilled orders were suspensions.

In the month of January net orders and shipments from the factory showed a rise, but so did the balance in stock in the hands of the dealers. As the shipments went out at only half the production rate, the number of parts finished during the month amounted to as much as would be shipped in two months. The line of actual shipments to the consumer flattened out faster than the line of total shipments, due to the dealers' stock gradually getting larger and larger. With production going straight ahead, the manufacturer's finished stock also grew larger.

For three months the "Production Started" and "Production Finished" lines ran parallel. Supposedly, after February cancellations, and poor sales in March, the manufacturer began to slow down the amount of work completed, although in April he started the usual amount of new work.

The executive using the chart illustrated did not control production with an eye on the actual sales to users, and he greatly over-anticipated sales. The users actually took thirty-three units in ten months, while the manufacturer finished 120 units, counting his own and the dealers' stocks. An over-anticipation of this kind means at the least a period of idleness for the producer. When the whole industry is in the same condition, it indicates such a serious maladjustment between actual supply and demand that loss to someone is inevitable. A chart of this sort is good not only for individual concerns but also for the industry as a whole.

The Metal-working Industries

REPORTS on conditions in the machine tool field vary considerably according to the line of machines built. Some manufacturers say there has been a decided improvement during the last three months, while others find insufficient change to warrant making definite plans as yet, based on increases in their business. But the fact is that there has been, on the average, a marked improvement. There has been more actual buying of machine tools during this period than in any other three consecutive months of 1921. This can be stated with certainty, and is confirmed by machine tool dealers, some of whom have done enough business during the last three months to pay running expenses and overhead, which very few found possible during the early part of the past year.

The small tool business shows a greater degree of activity than the machine tool trade, and while these shops also are all running on very much reduced schedules, it is interesting to note that, compared with pre-war sales, the present business is not abnormally low. One manufacturer of small tools is doing 70 per cent of his pre-war business, and another confidently expects to equal his pre-war sales during the coming year. Even in the machine tool field there are instances where present output is equal to 40 per cent of present capacity, which in many cases is equal to the manufacturers' pre-war business.

General Outlook in the Machine Tool Field

The prospects for 1922, upon which manufacturers generally agree, is that business will improve slowly during the first eight months or so, and the pace will be more accelerated during the last four months of the year. Many manufacturers and dealers expect that 1923 will be a normal year in this field, meaning by normal, a business that will sustain the industry as a whole, although by no means demanding the entire capacity at present available for machine tool building—a capacity expanded to meet the extraordinary demands of the war period, and, therefore, far in excess of peace requirements.

It is not unreasonable to expect, however, that in a few years even this excess capacity will be absorbed; at least, the history of the machine tool industry in this country warrants the belief that it will be. Time and again, during periods of depression, it has been generally held in the industry that capacity greatly exceeded the requirements for many years, but as soon as the business pendulum swung back to prosperity the machine tool plants found themselves working to full capacity and under the necessity of increasing their facilities. Periods of extreme depression and of unusual activity are now recognized as inevitable in the machine tool industry, for the reason that this basic industry is active only when other industries are expanding.

Demand for Cost-reducing Machinery

It is interesting to note that even though very little of the present machine tool equipment is employed, manufacturers are, nevertheless, buying certain types of high-production machinery and discarding the less productive in order to reduce manufacturing costs. With this object in view, orders have recently been placed for some highly automatic machinery, and machine tool manufacturers are concentrating on the development of types that will increase production and reduce labor costs. One of the machines recently completed doubles production without increasing labor costs, while the first cost of this equipment is increased by only 15 per cent. In another case the rapidity of performing a certain operation on automobile parts has been so improved within the last two years, through the efforts of two competing manufacturers, that the output is now three times what was formerly considered extremely good production. It is believed that the next two years will see some remarkable advances in machine tool design, and particularly in the field of automatic and semi-automatic machinery.

The Iron and Steel Industry

The iron and steel industry—the basic industry and the barometer for the entire metal-working field—is definitely looking toward better business during 1922, and is justified in this by steady markets and the slightly improved percentage of operation during the month of January. The United States Steel Corporation is operating at about 45 per cent capacity, and the independent companies, on an average, at nearly this percentage. Pig iron production for December was the largest since last February, and additional furnaces have been blown in. Taking an average of all iron and steel products, the output in 1921 was about one-half that of 1920. The exports of iron and steel products have steadily increased since September.

The Automobile Industry

During 1921, 1,535,000 passenger cars were built, and approximately 145,000 trucks. The export trade fell off heavily, as compared with 1920. In that year 140,000 passenger cars and 30,000 trucks were exported, as against 31,000 passenger cars and 8000 trucks in 1921. The figures show that the output of automobiles and trucks in 1921 was approximately 80 per cent of the output in 1920, the banner year in the automobile industry. The production for 1921 was far in excess of expectations in the automobile trade a year ago, and this great industry may be considered to have made a very rapid and quite remarkable recovery from what was expected to be not only a severe but a rather lingering depression. For 1922 it is estimated that practically the same number of cars will be built as in 1921.

The General Price Situation

The Federal Reserve Bank of New York regularly computes the average price of twelve basic raw materials, and the most recent compilations show that this price has remained close to the 1913 average ever since last July. This not only indicates stability in the prices of raw materials, but also a basic price level upon which to establish prices in all other industries at levels likely to restore confidence and encourage activities in all fields.

In machine tools there have been decided reductions, and the best thing for this industry now would be the establishment of prices based upon present labor and material costs and a strict adherence to these prices. Until definite price levels are generally maintained, manufacturers will have difficulties with buyers, who naturally seek bottom prices when there is no stability.

MACHINERY on many occasions has stated the reasons why there is no possibility of a return to pre-war prices for machine tools. The improvements made in all kinds and types of machines increase their manufacturing costs as well as their efficiency. The skilled labor employed in the manufacture of machine tools is also on a permanently higher wage level than before the war, and selling expenses have materially increased as a result of increased freight rates, passenger fares, hotel expenses, and similar items on which the advances have been very great and the reductions relatively insignificant.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application

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Heald Automatic Ring Grinding Machine

CONSIDERABLE interest was manifested at the automobile show held in New York City the early part of January, in an automatic surface grinding machine developed for grinding the sides of such circular parts as piston-rings, ball and roller bearing races, collars, washers, gears, and valve seats, on a quantity production basis. This machine, known as Style No. 25, was exhibited by the Heald Machine Co., 16 New Bond St., Worcester, Mass., and was set up for the grinding of piston-rings which were automatically fed to the wheel. In addition to the applications mentioned, it may also be employed for general work. One of the unusual features of the machine is that the wheel-slide is driven through a simple hydraulic arrangement operated by oil, which enables any speed from zero to maximum to be instantly obtained, and allows the table to be reversed instantly at any point without shock. This hydraulic arrangement may be seen in Fig. 1, attached to the front of the column.

The automatic feeding of the work to the grinding wheel is effected by means of a patented device, it being only necessary to load the magazine and take away the finished product. As will be seen by reference to Figs. 3 and 4, the device consists of a feeding plate having five holes bushed to take rings up to 5 inches in diameter. As the plate indexes, a ring is slid from the magazine to the center of the magnetic chuck, where it is ground by the wheel and then slid from the chuck. The feeding plate is indexed by a lever connected to a crank disk at the back of the machine, which

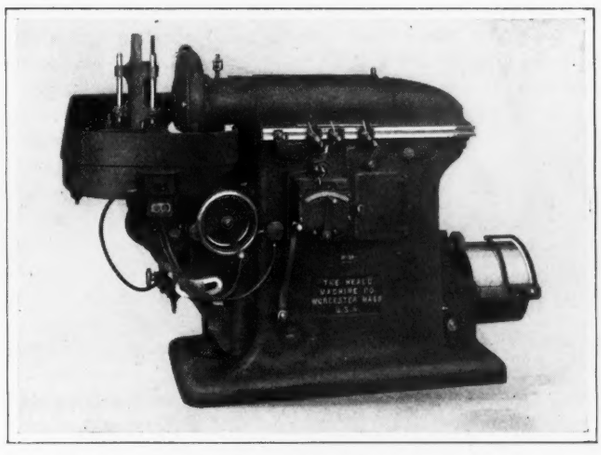


Fig. 1. Automatic Surface Grinding Machine developed by the Heald Machine Co.

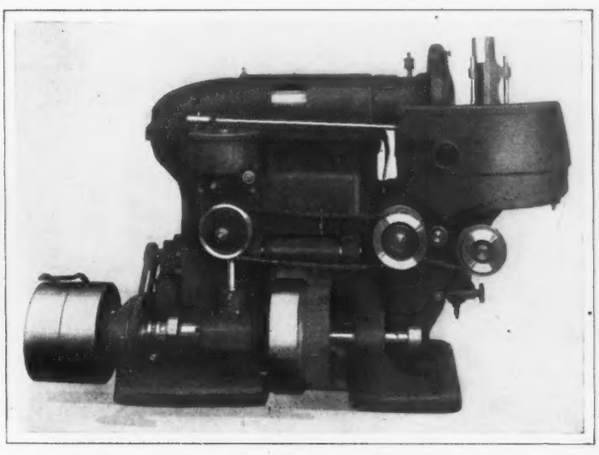


Fig. 2. Rear View of Grinding Machine, showing the Main Driving Shaft

is operated by a simple friction device. This disk is held stationary by a latch while the wheel-slide moves forward to enable the wheel to grind the ring on the chuck, but as the wheel-slide returns, the latch is tripped, allowing the crank disk to revolve and thus index the feeding plate one-fifth of a revolution. A guard placed over the ring being ground prevents any danger of flying parts in case the ring should break.

The wheel-spindle is made of chrome-vanadium steel, and it is mounted in an adjustable bearing at the wheel end. Adjustment of this bearing can be readily effected through an opening in the top of the wheel-slide. The rear end of the spindle is mounted in a self-aligning ball bearing. The main driving shaft is located at the rear of the machine, as illustrated in Fig. 2. It is mounted in roller bearings and has a two-step cone pulley giving two speeds to the grinding wheel, thus enabling the wheel to be run at an efficient surface speed throughout its entire life.

The chuck spindle is mounted in ball bearings and driven through spiral gears, the spindle housing being absolutely tight so that the bearings and gears may always be immersed in oil. When the machine is used for general work without the automatic feeding device, the chuck bracket can be adjusted to permit concave and convex surfaces to be ground. A diamond located on the chuck pan can be readily adjusted to true the wheel so as to obtain the desired thickness of the work. In order to bring the wheel in position for dressing, the left-hand reversing dog, seen on the wheel-slide in Fig. 1, is thrown up to allow the slide to travel toward the back of the machine until the reversing lever engages a safety latch-dog. The latter controls the reciprocations of the slide past the diamond. The dogs on the front of the machine, besides controlling the travel of the wheel-slide, also govern the action of the feeding device.

A disk at the rear of the machine equipped with an electrical contact, furnishes current for the chuck at the time that the work is being ground. However, as the disk revolves the current is automatically shut off for an instant and reversed, thereby demagnetizing the chuck and the work before the latter is removed. By the time the next ring is slid into place over the chuck, the current is automatically switched on again. An automatic vertical feed can be furnished with this machine when it is to be used for general work, but this device is not adaptable to a machine furnished with the ring-feeding device. A water equipment, including a pump, tank, water guard, and connections, can also be furnished when desired.

This machine can be equipped with an 8-, 12- or 16-inch magnetic chuck, but the automatic feeding device for rings can be furnished only with the 8-inch size. Some of the principal dimensions of the machine when equipped with an 8-inch chuck are as follows: Maximum and minimum distances from top of chuck to center of grinding wheel, 12 and 4¾ inches, respectively; vertical adjustment of chuck, 7¼ inches; maximum diameter of work automatically handled, 5 inches; and maximum thickness, 2 inches. When the machine is to be driven directly by a motor, a 10- to 15-horsepower size is recommended, depending on the nature of the work.

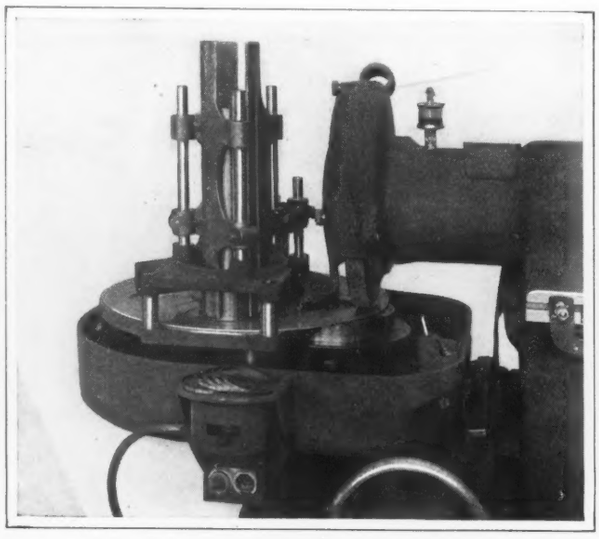


Fig. 3. Close-up View of the Grinding Wheel, Magnetic Chuck, and Automatic Feeding Device

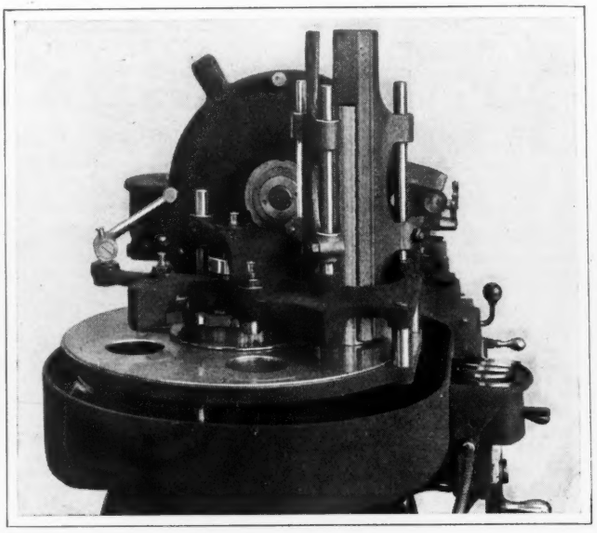


Fig. 4. Another View of the Automatic Feeding Device, looking directly toward the Grinding Wheel

ABBOTT BALL BURNISHING BARREL

The principal feature in which the ball burnishing barrel shown in the accompanying illustrations differs from other burnishing barrels manufactured by the same concern is in holding the articles to be burnished stationary on the inside of the barrel body and carrying them through the mixture of balls, soap, and water, whereas in previous designs the work was placed in the barrel loose and allowed to tumble in the mixture. This machine was brought out by the Abbott Ball Co., Elmwood, Hartford, Conn., to enable large work to be burnished without the different pieces coming in contact with one another in such a way as to scratch their surfaces. The periphery of the barrel is eight-sided, each side having a hinged hand-hole cover over an opening into the barrel.

The edges of the openings are beveled to an angle of 45 degrees, and a lid machined to suit these bevels fits into each opening. This lid is held in place by the hinged cover coming in contact with a flat spring on the top of the lid, which also serves as a handle to facilitate the removal of the lid. The hinged covers have packing rings which prevent the mixture from leaking out of the barrel. On the inside face of each removable lid is attached a fixture for holding the work it is desired to burnish. Fig. 2 shows a barrel with a portion broken away to show the manner in which it is equipped for burnishing parts of hacksaw frames.

The machine is designed primarily for the use of manufacturers having large quantities of one or more classes of work to be burnished. Two or three sets of lids may be provided, equipped with fixtures suitable for the different classes of work. Then, in operating the machine, while eight fixtures filled with one class of work are being revolved in the barrel, another set of fixtures can be unloaded and loaded. After the work has been finished, it is removed from the barrel by lifting each hinged cover in succession and raising the corresponding lid and work-holding fixture. Of course, another fixture with unfinished work is put into place in each instance before the next hinged cover is raised, so that the mixture is retained in the barrel.

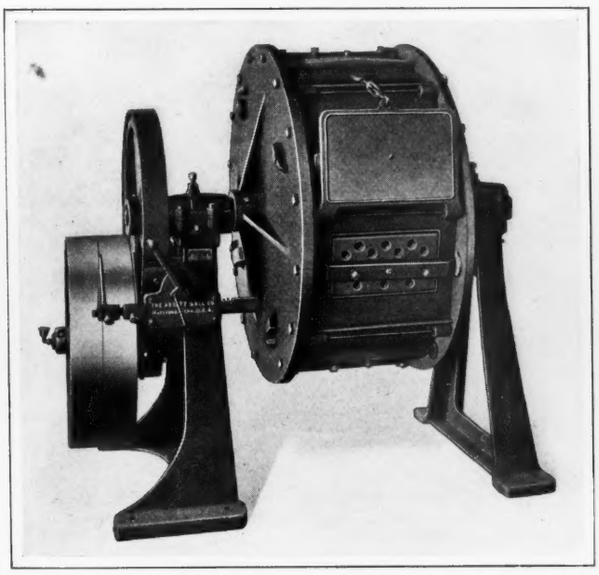


Fig. 1. Ball Burnishing Barrel which is a Recent Development of the Abbott Ball Co.

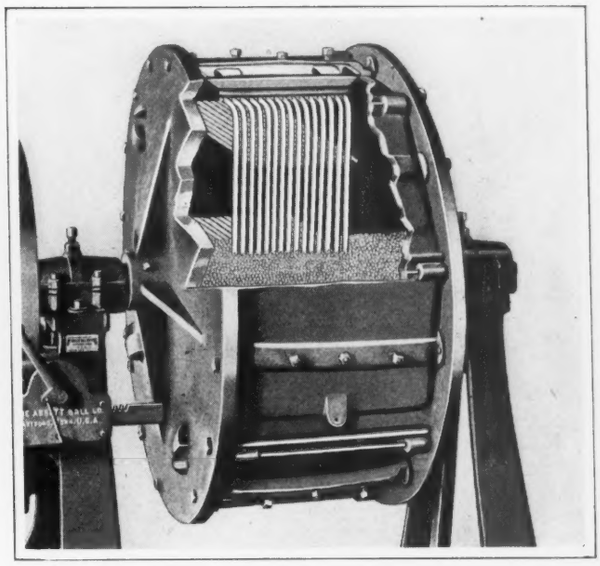


Fig. 2. Close-up View of Barrel broken away to show Manner of holding the Work

With work that is to be plated, it will be found advantageous to have at least three sets of fixtures so that when the work is removed from the barrel ready to be plated, it may be left on the fixtures while being put through the plating operation and then brought back to the burnishing barrel for the final burnishing. Fig. 1 shows the method of holding the hinged cover in a raised position and also shows a lid fitted up with wire screening. This screening is of a mesh that will not allow any of the balls to come out, and is for the purpose of furnishing an easy method of keeping the inside of the barrel and the balls clean. In cleaning the barrel, it is first filled with water, then the strainer cover is put in place, and the barrel revolved. The inside of the barrel and the balls are satisfactorily rinsed in this way.

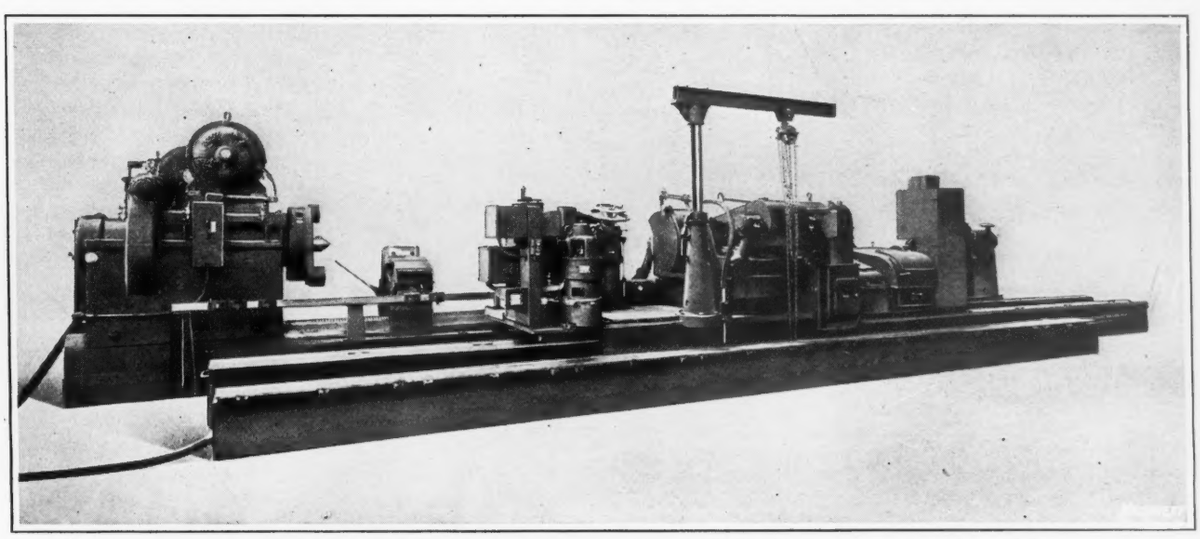
NORTON ROLL-GRINDING MACHINE

Two cylindrical grinding machines of the single-wheel type, designed for dressing steel-mill rolls up to 54 inches in diameter and 28 feet in length, have been recently installed in the shops of the Jones & Laughlin Steel Co. by the Norton Co., Worcester, Mass. These machines are among the heaviest of their class ever built, weighing about 50 tons, and are quite similar in design to other Norton machines built in the past for the same purpose. Each machine is electrically driven and controlled throughout. Four Westinghouse motors are provided, a 40-horsepower unit being mounted on the wheel carriage for revolving the grinding wheel and traversing this carriage, a 20-horsepower motor on the headstock for revolving the work, a 3-horsepower motor on the footstock for traversing this member along the ways of the work-base, and a 3-horsepower motor on the wheel carriage for driving the pump and traversing the grinding wheel at right angles to the work.

The operation of the machine is governed by magnetic controllers, the position of the operator being on the wheel carriage and beside the grinding wheel, where he may look down between the work and grinding wheel faces and observe the grinding process.

The rolls may be rotated either between centers or on specially constructed adjustable bearings. Within the reach of the operator are all the handwheels and levers necessary for starting and stopping the wheel, starting or stopping the roll, reversing the traversing wheel carriage either by hand or by power, moving the wheel carriage for slight adjustments by hand, moving the wheel toward and away from the work either by hand or by power, starting or stopping the traverse of the wheel carriage, changing from the maximum to the minimum speed of the wheel-carriage traverse, and controlling the amount of water or coolant flowing over the wheel and work.

Changes in the speed of the work are accomplished at the headstock by means of a drum controller and change-



Cylindrical Grinding Machine built by the Norton Co. for Rolls up to 54 Inches in Diameter and 28 Feet in Length

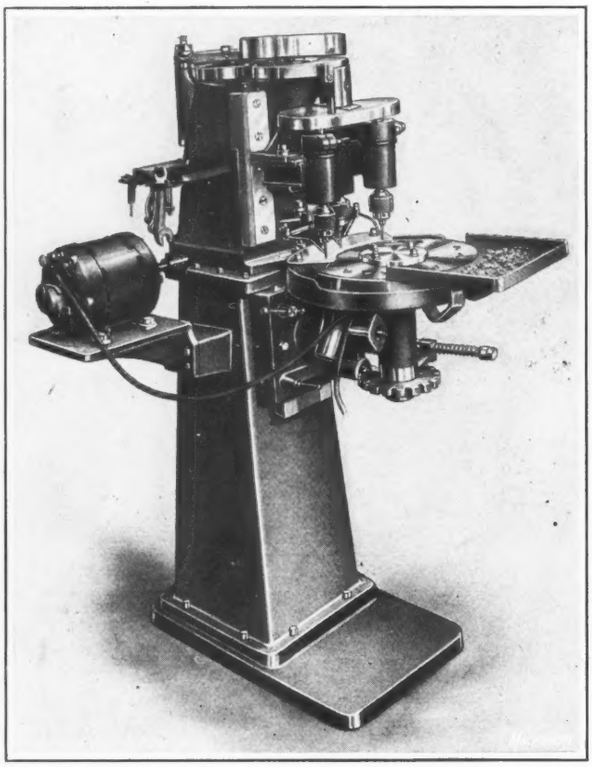


Fig. 1. Dial-feed Multiple-spindle Tapping Machine which is a Recent Development of the Anderson Die Machine Co.

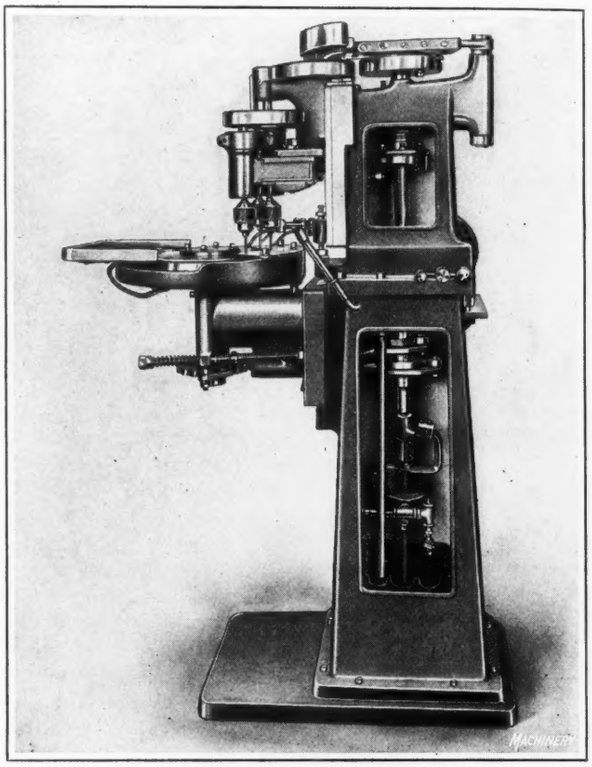


Fig. 2. Left-hand Side of Machine with Various Covers removed to show the Operating Mechanism

gears, while four speed changes for the traverse of the wheel carriage are effected by means of a lever on the front of the carriage. Eight speed changes are possible for this unit through the use of back-gears. An attachment adjustable to any radius up to 3½ inches is furnished for forming the corner of the grinding wheel to suit the grinding of fillets, while the truing device maintains the face of the wheel.

ANDERSON DIAL-FEED MULTIPLE-SPINDLE TAPPING MACHINE

To make possible high rates of production in the tapping of small steel and brass parts used extensively in the construction of electrical appliances, or in tapping nuts and other small pieces requiring a number of tapped holes, the Anderson Die Machine Co., Iranistan Ave. near Admiral St., Bridgeport, Conn., has produced a dial-feed multiple-spindle tapping machine which has a number of novel features incorporated in its design. The general appearance of the machine is shown in Figs. 1 and 2, from which it will be seen that it is equipped with three tapping spindles, while Fig. 3 shows the mechanism employed for alternately rotating the spindles in opposite directions. This alternate rotation is obtained by means of a crank disk mounted on the top of a vertical shaft located at the center of the machine and extending to the top. The crank disk moves a large gear tooth segment to and fro, the teeth of which engage a train of gears connecting with pinions at the top of the spindles.

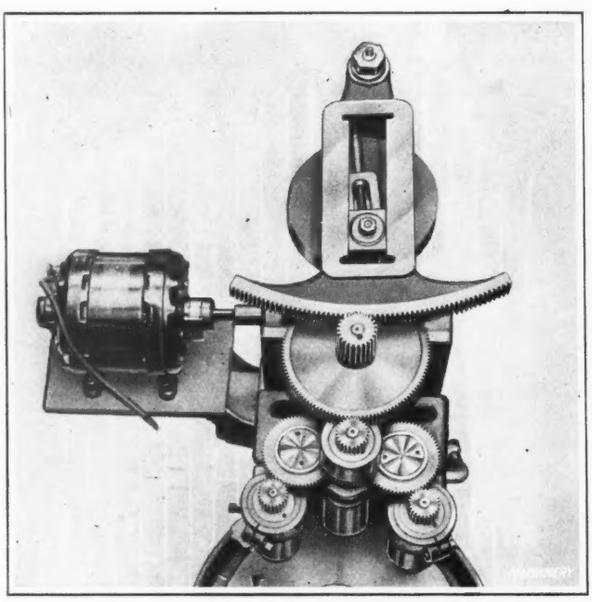


Fig. 3. Plan View of Tap-spindle Reversing Mechanism

The work-holding dial is indexed by means of cams mounted near the middle of the vertical shaft, which lock the dial in position after each indexing. The ratchet that controls the dial operation is regularly furnished with eighteen teeth to correspond with the number of openings usually supplied around the dial for the work. The dial is made of relatively thin material, and the openings are made to fit the particular pieces to be operated on. Parts of various shapes may be accommodated by simply substituting a dial with openings of the necessary contour. Any piece requiring one, two, or three tapped holes can be tapped at one movement of the dial past the spindles, and on account of the construction of the spindles, three taps of entirely different leads may be employed at the same time.

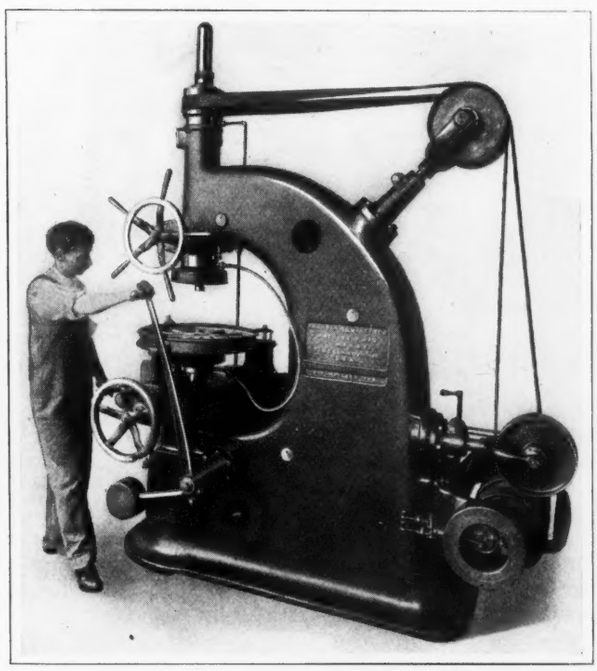
The two end tapping spindles are adjustable so that holes in various positions may be tapped. Each dial is designed to suit the fixed central spindle and then is located and indexed in such a way as to make one hole register with the fixed spindle, the two auxiliary spindles being finally adjusted to suit the location of the other holes to be tapped. When the machine is used for tapping holes of the general sizes met with in electrical work, namely from No. 4 to 10, the taps are operated at the rate of fifty-six strokes per minute, which gives an hourly production of 3360 pieces having either one, two, or three holes.

On pieces where only one hole is to be tapped, it is possible to increase the production 100 per cent by doubling the number of work slots in the dial, which can be conveniently done by staggering

them, and adjusting one of the auxiliary spindles to suit the work held in the staggered openings. With this provision, the production on single-hole tapping is approximately 112 pieces per minute. By furnishing a cam and slide which will work in conjunction with the dial, the machine may be modified so that round pieces can also be tapped without difficulty. Ball bearings are provided for all shafts that run at comparatively high speeds, and all gears are accurately cut. The machine is driven by a direct-connected motor mounted on a bracket attached to the left side of the column.

BLOMQUIST-ECK DOUBLE-FACING AND BORING MACHINE

The Blomquist-Eck Machine Co., 1146 E. 152nd St., Cleveland, Ohio, has designed the double-facing and boring machine shown in the accompanying illustration. The machine, as illustrated, is used for facing and boring automobile wheels at one setting, to insure that both sides of the wheel will be parallel. There is one cutter-head above the work and another below it in the base of the machine. After the wheel to be operated upon has been chucked, the hand-lever being actuated by the operator in the illustration brings up the lower head, which faces the under side of the wheel. As the spindle of this head moves upward, it brings a gage with it, which the operator locks upon the completion of the lower facing operation. He then brings down the upper facing spindle, which bores the hole and faces the hub simultaneously. As this spindle is brought down, a rod controlled by it strikes the gage referred to, at the time when the wheel has been faced to the right thickness, and prevents further downward movement of the spindle. The spindles are then moved to their original positions, the gage released, the wheel removed, and another wheel put in place, after which the operation is repeated.

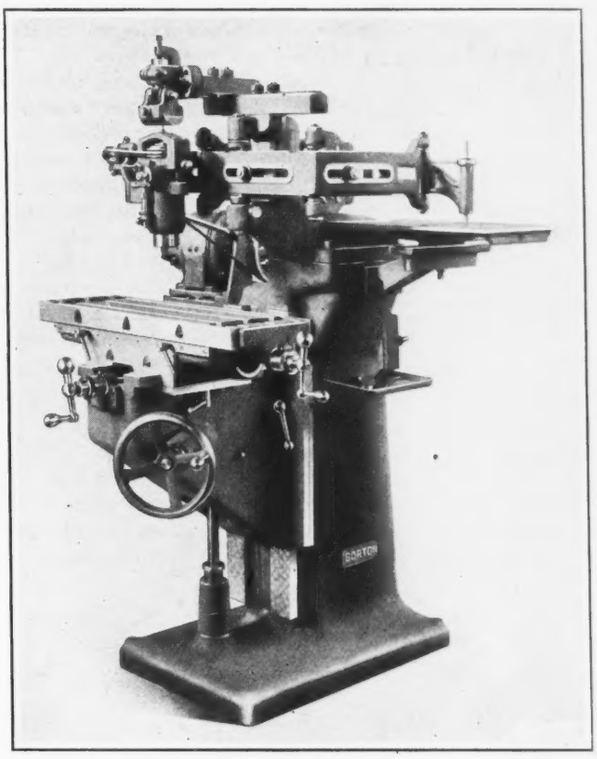


Machine developed by the Blomquist-Eck Machine Co. for boring and facing Automobile Wheels

The oiling system provides for lubricating the upper drive-pulley bearing, the upper spindle quill, and the lower spindle quill by one continuous flow of oil, a flexible tube connecting the upper and lower spindle quills. The pump can be adjusted to supply any necessary amount of oil. The machine is provided with S K F ball bearings throughout. The drive from the countershaft in the back of the machine to the spindle quills is through 3-inch single-ply belts.

GORTON HEAVY ENGRAVING MACHINE

To meet the demands for a heavy engraving machine suitable for cutting dies, steel stamps, and large-size letters, and for handling other similar jobs in steel, brass, and cast iron, the George Gorton Machine Co., Racine, Wis., has developed the No. 1-S engraving machine, which is heavier and has a greater capacity than the machines previously built by this concern. On the new machine the pantograph may



Heavy Type Engraving Machine developed by the George Gorton Machine Co.

be set for various reductions of from 1 to 1 down to 6 to 1. Both radial and thrust ball bearings are provided for the pivots, all other pantograph bearings consisting of hardened, ground, and lapped male and female cone-point centers. The tracing style is held in a ½-inch collet and the adjustable scales are mounted on the top surfaces of bars. The scales have engraved figures giving the settings for the various reductions, and are graduated the full length with twenty graduations to the inch.

The cutter-head is an integral part of the heavier of the pantograph bars. Its spindle is mounted on ball bearings and regularly has a range of from 1800 to 8000 revolutions per minute, thus enabling small cutters to be used for fine work and finishing up corners. However, spindle speeds down to 600 revolutions per minute may be obtained by using special driving pulleys. The spindle nose has a straight hole ⅜ inch in diameter, and a collet nut for holding cutters. Extra bushings can be supplied for taking drill-rod cutters less than ¼ inch in diameter.

A heavy spindle running in bronze bearings and at slower speeds than those specified can also be furnished in place of the ball-bearing spindle or as an addition to the regular equipment. The table is 10 inches wide, 30 inches long, and provided with three T-slots. An oil-groove planed along each edge allows the cutter lubricant to drain into pockets at the ends of the table. This member is gibbed to take up wear, and a lock-screw provides for holding it in the desired position.

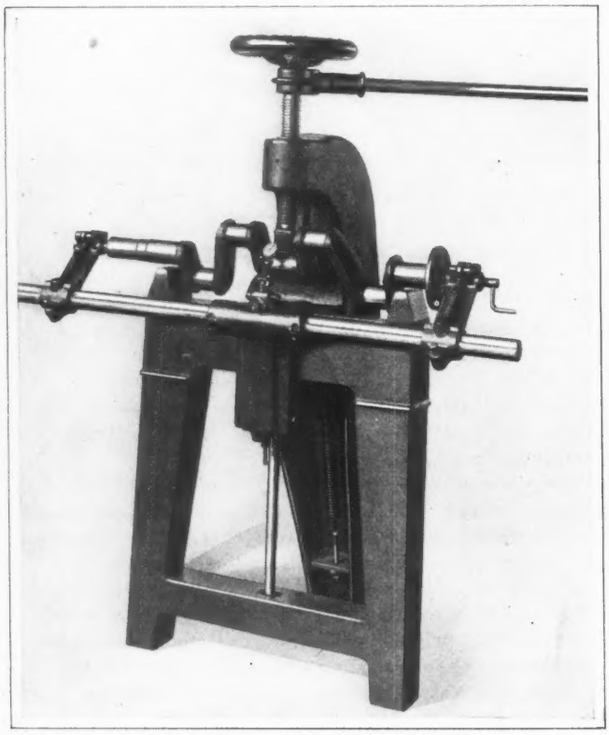
When engraving work of curved or irregular contour, the forming attachment used has six different adjustments which permit it to be set quickly and accurately relative to the work to be engraved. The lower member of the attachment

is located directly over the center of the spindle and carries the former block, which is a hardened piece of steel of the same shape as the engraved surface except in the reverse. This block controls the vertical movements of the spindle. The copy-holder is mounted on a bracket at the right-hand side of the machine and is adjustable to compensate for changes in the reduction of the pantograph. The machine is regularly equipped with a copy-holder to suit the work to be handled, and a considerable variety of these can be furnished. Those who have smaller machines built by this concern can utilize any of their copy-holders on this machine through the use of an adapter.

Some of the important dimensions of the machine are as follows: Longitudinal feed of table, 17½ inches; cross-feed of table, 8¼ inches; minimum distance from nose of spindle to top of table, ½ inch; and maximum distance from nose of spindle to top of table, 16 inches. The approximate weight of a belt-driven machine is 1800 pounds, and that of a motor-driven machine 1950 pounds.

GEIER PRODUCTION STRAIGHTENING PRESS

A No. 2P straightening press intended for handling large quantities of parts without removing them from between centers has been recently developed by the P. A. Geier Co., Cleveland, Ohio. The round bar on which the center brackets are mounted is fitted to a sliding head provided with a roller bearing. The bar can be moved freely to the right or left to permit the straightening or bending of work at any point along its length. The sliding head unit is pivoted to the



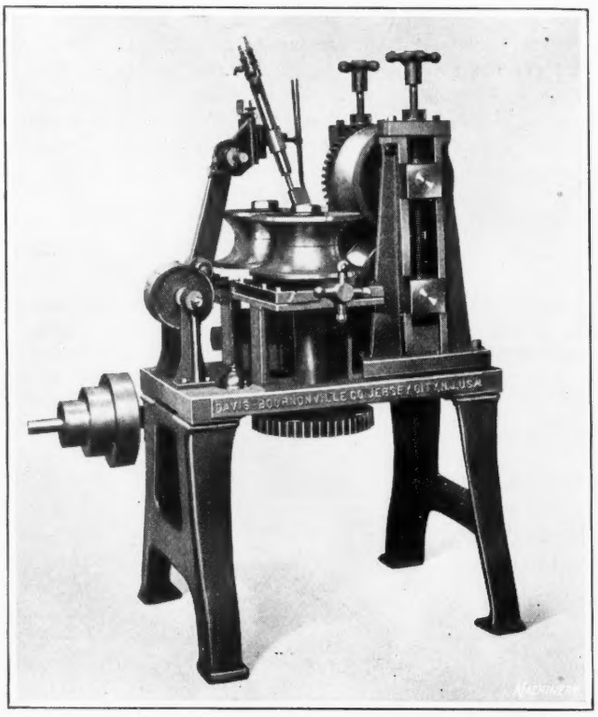
Production Straightening Press placed on the Market by the P. A. Geier Co.

frame of the press and held in a horizontal position by a vertical shaft equipped with a compression spring on both sides. The head also has an up-and-down movement obtained by means of a spring in the rear leg, which is connected by a cable. An adjustable stop-screw enables set-ups to be made that permit the work to clear the blocks.

The handwheel is graduated in twenty-five equal spaces and by turning it through one space a 0.0001-inch up or down movement of the pressure screw is obtained. The amount that a part is out of truth can be read in thousandths of an inch from a dial indicator supplied with the machine and used with the work placed between the centers. This indicator has a ¼-inch stroke. A few of the principal dimensions of the press are as follows: Length of bed, 26 inches; distance from center of screw to frame, 4 inches; maximum distance from bed to thrust block on screw, 8 inches; minimum distance, 2 inches; and maximum distance between centers, 40 inches. The net weight of the machine is about 500 pounds.

DAVIS-BOURNONVILLE TUBE-WELDING MACHINE

An oxy-acetylene tube-welding machine designed for the quantity production of large-diameter thin gage tubing has just been brought out by the Davis-Bournonville Co., Jersey City, N. J. This machine is especially intended for use in tube manufacturing plants where it will be set up and used



Quantity-production Tube-welding Machine added to the Line of Equipment built by the Davis-Bournonville Co.

for long runs on one size of tubing. It has two pairs of rolls, one for feeding and the other for welding. The drive is by belt to a three-step cone pulley mounted on a shaft at the rear. This shaft also carries a pinion which drives a spur gear keyed to a shaft having two worms. Motion is transmitted to the feed and welding rolls through a worm-wheel on one spindle of each pair. The worm-wheel driving the feeding rolls is in a vertical position, and that for the welding rolls is in a horizontal position.

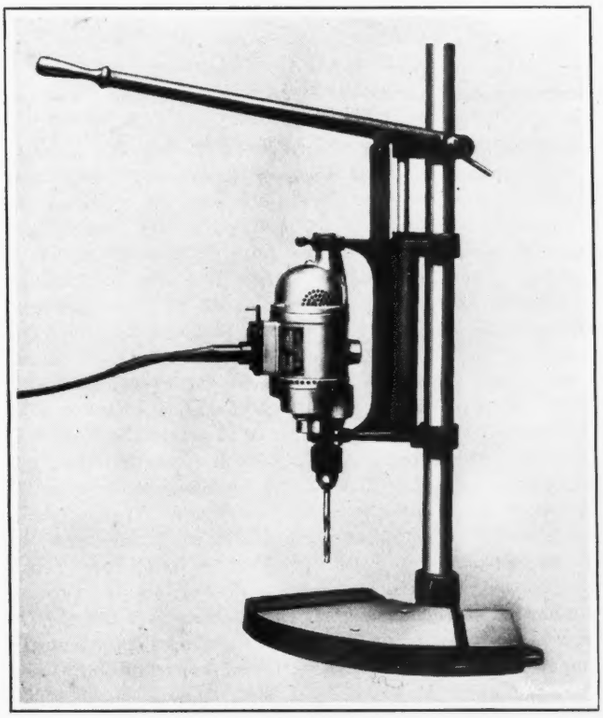
The back welding roll is fixed in place, while the one in front is adjustable, its spindle bearing being in a slide, the position of which is controlled through a screw and hand-wheel. The mating gears of the rolls have involute teeth of a comparatively large diametral pitch, which permit adjustments within the range to be made without affecting the smoothness of the tooth action. The upper and lower feeding rolls are geared together, and in this case adjustment is also made by moving one of the rolls and its mating gear. The welding rolls have annular depressions on top to receive cooling water, and a circulatory system can be provided when essential.

The welding torch is of the Davis-Bournonville multiple-jet water-cooled type. Both the tip and the barrel of the torch are cooled by the circulation of water to maintain the

conditions necessary for successful continuous welding. The torch-holder permits vertical and horizontal adjustments of the torch and varying of the angle at which the tip is presented to the seam to be welded. The maximum capacity of the machine is for tubing 6 inches in diameter, made from No. 10 gage. Although designed and built for the quantity production of one size and gage of tubing, as previously stated, the machine can be set up for any diameter and gage of tubing within its capacity by employing rolls grooved to suit the desired tube diameter. All rolls, whether for large or small diameter tubes, are the same size over all, and the normal center distances of their mating gears are the same.

UNITED STATES DRILL STAND

To accommodate portable electric drills so that they may be used as bench machines, the United States Electrical Tool Co., Sixth Ave. and Mount Hope St., Cincinnati, Ohio, has



Stand for Electric Portable Drills made by the United States Electrical Tool Co.

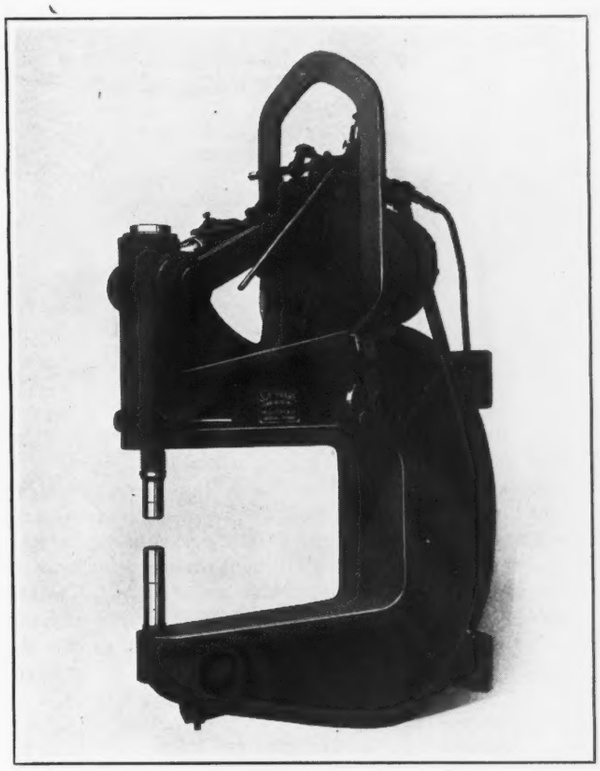
placed on the market the improved drill stand shown in the accompanying illustration. The unit to which the drill is attached may be clamped in various positions along the vertical bar to meet the requirements of the job. The drill is then raised and lowered for the operation through the manipulation of a long lever. The stand will accommodate the ⅜- and ½-inch drills manufactured by this company, and without a drill weighs approximately 68 pounds.

MILBURN OXY-ACETYLENE WELDING OUTFIT

An oxy-acetylene welding unit, which is also provided with a tube that adapts the apparatus for burning carbon from automobile cylinders, has been placed on the market by the Alexander Milburn Co., 1420-1428 W. Baltimore St., Baltimore, Md., for use in machine shops and service garages. In addition to the carbon-burning tube, the equipment consists of a welding torch, five welding tips, single-gage oxygen and acetylene regulators, oxygen and acetylene hose, and several other parts used in welding. The outfit is contained in a fiber case. The welding torch is 16 inches long, and of the balanced pressure type operating on approximately equal pressures of oxygen and acetylene. All mixing takes place in the tip. The seats of the regulators close with the pressure rather than against it, thus enabling them to be closed by the exertion of several pounds pressure. The carbon-burning tube fits into the torch-head similarly to a welding tip. It may be conveniently attached and replaced as it becomes worn out.

SOUTHWARK PNEUMATIC RIVETING MACHINE

A line of pneumatic riveting machines made in various capacities from 10 to 150 tons is now being built by the Southwark Foundry & Machine Co., Philadelphia, Pa. On these machines movement is given to the die through a toggle action which causes the die to advance rapidly to the rivet at a decreasing rate of speed and an increasing tonnage, after which the movement is at a uniform speed and pressure for a sufficient distance to drive the rivet tight, drawing the plates together and following up the shrinkage of the rivet with full pressure. It is unnecessary to drive the rivet at the end of the die travel or piston stroke, it being intended that the die be set for any run of work so that the rivet will be headed when the piston has moved through about three-quarters of its stroke, thus allowing a sufficient die travel at full pressure on either side of this position to take care of variations in lengths of rivets, thickness of plates, dimensions of holes, etc., without necessitating further adjustment of the die screw to be made.



One of a Line of Pneumatic Riveting Machines developed by the Southwark Foundry & Machine Co.

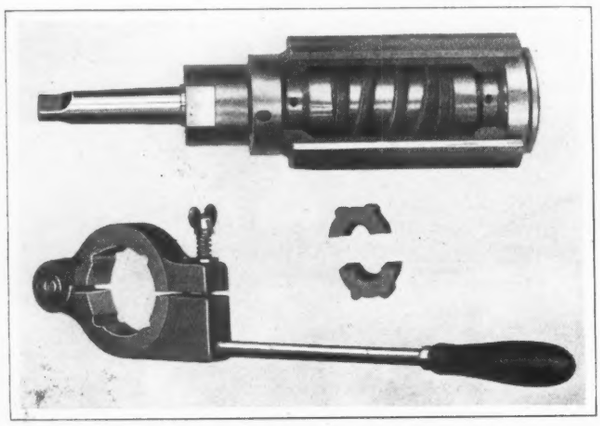
The first inch of piston stroke results in a travel of 1¾ inches of the die, which, owing to the fact that the power delivered to the die is in inverse proportion to its movement relative to the piston, develops only four-sevenths of the power actually exerted on the piston. Thus, if a 5-ton pressure is exerted on the piston, only 2.85 tons will be exerted by the die in this position. In the second inch of piston stroke, the rivet die advances 7/16 inch, exerting a pressure of 11.4 tons, and in the third inch of piston stroke, the die advances 5/16 inch, exerting a pressure of about 16 tons. For the ninth and each succeeding inch of piston

stroke, the die advances 1/12 inch and exerts a pressure of about 60 tons on the die, this pressure being maintained for ½ inch of die travel.

The operating valve is of the plain sliding type having a simple wick packing on the stem and a removable valve seat which permits ready regrinding. It is provided with means for using line pressure in the pull-back. Two separate pressures may be supplied to the rivet die by turning a plug cock in the valve plate to admit air at full pressure in the pull-back area. This reduces the pressure to the next lower tonnage rating, that is, a standard 50-ton machine will develop both 50- and 30-ton pressures on the die; a 75-ton machine, 75- and 50-ton pressures on the die, etc.

R & C INTERNAL AND EXTERNAL LAPS

The R & C Lap Co., Davenport, Iowa, has developed a line of internal and external standardized laps having interchangeable and replaceable soft metal shells charged with abrasive. The laps were designed especially for finishing parts of internal combustion engines, compressors, and similar apparatus. The shells are supplied in two grades to suit the speed of the operation and the type of work handled. It is stated that highly skilled labor and much experience are unnecessary in order to secure a satisfactory finish with these laps. They are made in various sizes above ¼ inch.



Cylinder and Crankshaft Laps brought out by the R & C Lap Co.

A cylinder lap is shown in the upper part of the accompanying illustration with one section of the shell removed to show the internal construction. This lap consists of a floating shank and expanding device that permits adjustment of the lap diameter and also adjustment to compensate for wear of the soft metal shell. While expanding the lap, the diameter is kept constant throughout the length to insure a true bore in the work. The lap is expanded to the required size by the adjusting nut, and this setting is maintained by a locking nut. The standard shank permits the use of the lap in lathes and drilling machines or by hand.

The lap shown in the lower part of the illustration is of the external type and is used for lapping crankshafts. Another interesting lap made by this firm is a small internal lap intended for tool-room use. The patented construction of this lap permits a slight contraction which prevents the lap from sticking while being used. After a contraction, it cannot expand beyond the original micrometer setting.

H & G SOCKET- AND RATCHET-WRENCH SET

The illustration shows a wooden carrying case containing ten wrench-sockets for hexagonal nuts, which accommodate all sizes of nuts from 7/16 to 1 inch, inclusive; adjustable T-handle; reversible ratchet; universal joint; extension piece; two screwdrivers; and a box wrench. This outfit is

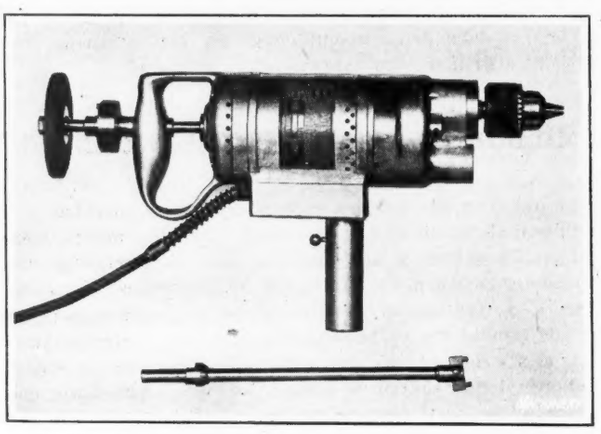
Socket- and Ratchet-wrench Set manufactured by the Eastern Machine Screw Corporation

now being introduced to the trade by the Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn. Attention is called especially to the manner in which the sockets are manufactured. The hole in each one is first drilled to the dimension across the corners of the nut it is intended to fit, and then the hexagonal shape is formed by drawing in the surrounding metal. This procedure condenses the metal and produces a tough structure. The sockets are provided on top with hexagonal heads by means of which they are turned by the use of the wrench members.

The T-handle has an adjustable cross-bar which can be used in a central position or adjusted to obtain the maximum leverage. The ratchet may be set for use by either the right or left hand by simply raising and reversing the position of a ball-head pin. The extension piece is used between the T-handle and a socket to turn nuts that would otherwise be difficult to reach, or to bring the T-handle into a more favorable position, and the universal joint provides for turning nuts located at difficult angles. Each female part has a split-screw made from spring steel, which produces the necessary amount of friction to hold the parts together while being used.

LOUISVILLE COMBINED PORTABLE DRILL AND GRINDER

One of the distinctive features of the new ⅜-inch portable electric drill now being introduced to the industrial field by the Louisville Electric Mfg. Co., Louisville, Ky., is the grinding wheel attachment made to fit the armature shaft.

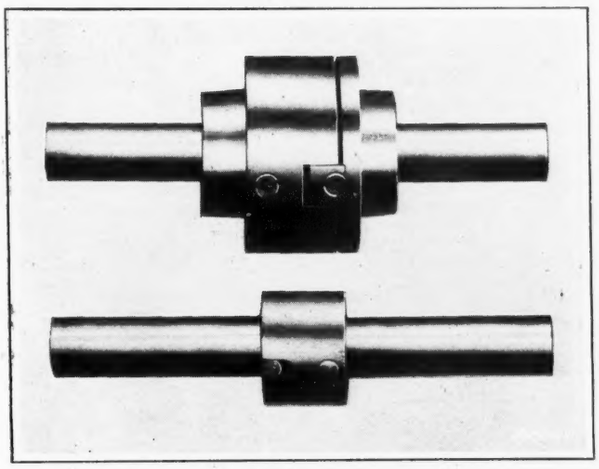


Portable Electric Drill with Grinding-wheel Attachment which is a Product of the Louisville Electric Mfg. Co.

This attachment extends through the handle of the drill into the body, and is equipped with ball bearings and a two- or three-inch grinding wheel running at the rate of 9000 revolutions per minute. The attachment can be inserted whenever the operator desires to sharpen drills or use it for grinding operations. The drill is adapted for use on a lathe. Built into the drill housing is an oscillating automobile-valve grinding device from which the bit holder can be removed at will. This provision makes the drill especially suitable for use in repair shops and garages. The drill motor operates on either direct or alternating current of 110 or 220 volts. The gears are made of heat-treated alloy steel, and aluminum castings are used throughout the construction in order to reduce the weight.

BARTLETT FLEXIBLE SHAFT-COUPLING

A patented flexible shaft-coupling which has a free turning motion around hardened steel pins and a sliding motion in a tongue and groove connection, is now being placed on the market by C. H. Breaker, 4226 Broadway, Indianapolis, Ind., under the name of the inventor, Bartlett. Two styles are shown in the accompanying illustration. The coupling maintains a uniform velocity ratio between the two shafts regardless of the amount of angular or lateral misalignment,



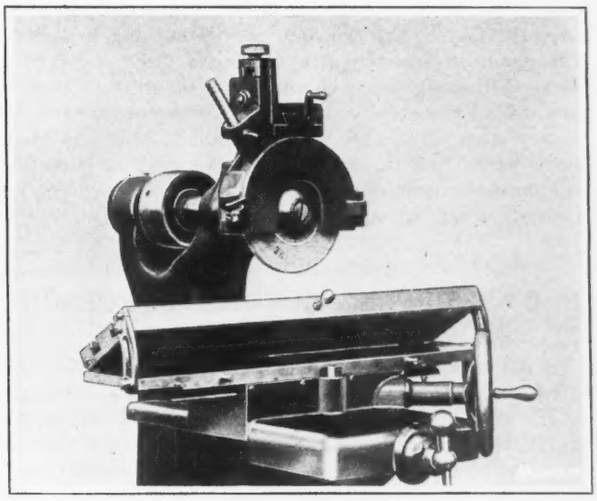
Two Styles of Flexible Shaft-coupling sold by C. H. Breaker

and allows the ample end float essential when couplings are used with alternating-current motor installations, the two sliding members of the coupling being simply pushed into or out of position as necessitated.

The style shown in the upper portion of the illustration consists of two hubs keyed to the shaft ends, two rings which engage each other by means of a tongue and groove construction, and bearing pins driven transversely into each hub. There is another style similar to this, except that the pins are driven directly into the shaft ends, and the hubs are omitted. With the style shown at the bottom of the illustration the pin in one of the shaft ends engages the slotted ring carried by the other shaft end. These coupling members are made of machine steel and heat-treated. With slight changes in the construction, a positive transmission can be had between shafts set at any angle up to 90 degrees.

WILMARTH & MORMAN SURFACE GRINDING MACHINE

In MACHINERY for December, 1921, was published an illustrated description of the No. 1 hand-feed surface grinding machine built by the Wilmarth & Morman Co., 1180 Monroe Ave., N.W., Grand Rapids, Mich., equipped with a swivel sub-table which adapted the machine for handling angular and irregular work. The same machine may now also be

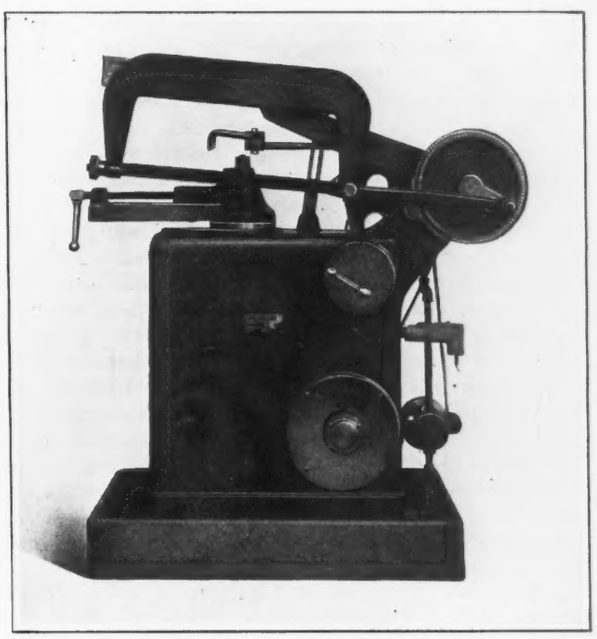


Tilting Table now made for the No. 1 Surface Grinding Machine manufactured by the Wilmarth & Morman Co.

supplied with a tilting table, as here illustrated. Suitable T-slots are provided on this table to accommodate a magnetic chuck, vise, or other fixture. Graduations in degrees facilitate the setting of the table to the desired angle for the work in hand. This design of the table obviates the necessity of tilting or blocking up one edge of a magnetic chuck in order to grind work at an angle. The truing device is conveniently located on the wheel-head, which permits the grinding wheel to be dressed straight or at any required angle without removing the work from the table. A radial truing device operating from the table can also be supplied.

LOUISVILLE MOTOR-DRIVEN HACKSAW

The Louisville Electric Mfg. Co., Louisville, Ky., has added to its line of products a hacksaw driven by a motor which, together with its control switch, is built into the machine so as to be out of the way and at the same time be protected from injury. The slide of the hacksaw is located above the blade for the purpose of keeping the sliding surfaces free from chips and grit. The vise swivels and is provided with graduations to enable the convenient cutting of work at various angles. The stroke of the machine is adjustable from 5 to 7 inches, and there are two speeds, either 45 or 90



Motor-driven Hacksaw brought out by the Louisville Electric Mfg. Co.

strokes per minute. The machine takes a saw 16 inches long, the feed of the saw into the work being by gravity. The motor stops automatically when a piece of work has been cut through. Ball bearings are contained in the construction of the motor and it can be furnished for operation on any circuit. The machine may be equipped with an oil pump when desired, and may also be used as a portable equipment by mounting it on wheels. The weight of this hacksaw is approximately 450 pounds.

BROWN DUPLEX AUTOMATIC FORMING MACHINE

In the line of work classed as screw machine products there are many pieces that can be made most economically by the method known as "form and cut-off." The duplex automatic forming machine shown in Figs. 1 and 2 has been developed by the L. P. Brown Machine & Tool Co., Attleboro, Mass., to produce parts rapidly according to this principle. The main feature of the machine is the use of two work-spindles which operate simultaneously as two separate single-spindle machines on different pieces of the same product. The machine will make any piece that can be produced with one forming and one cutting-off tool, or with a forming tool and a combined forming and cutting-off tool. This classification includes such parts as special shaped rivets, knobs, studs, handles, etc. By combining the productive capacity of two single-spindle machines in one machine, a saving in floor space, investment, and operating expense is realized.

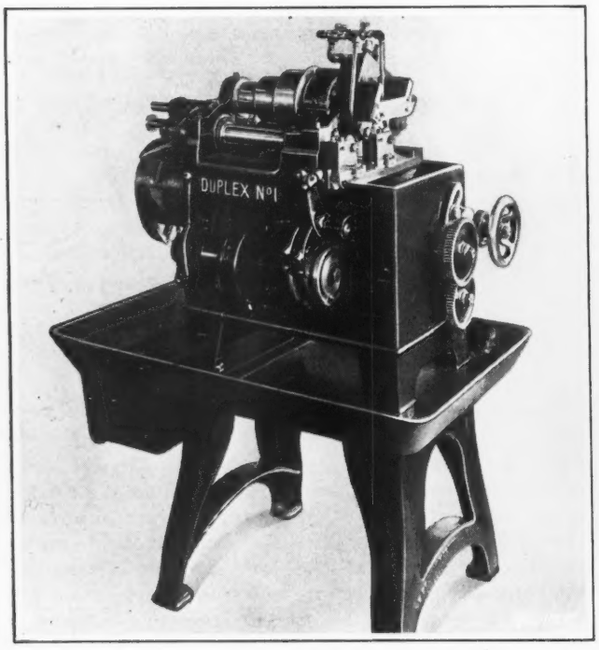


Fig. 1. Double-spindle Automatic Forming Machine made by the L. P. Brown Machine & Tool Co.

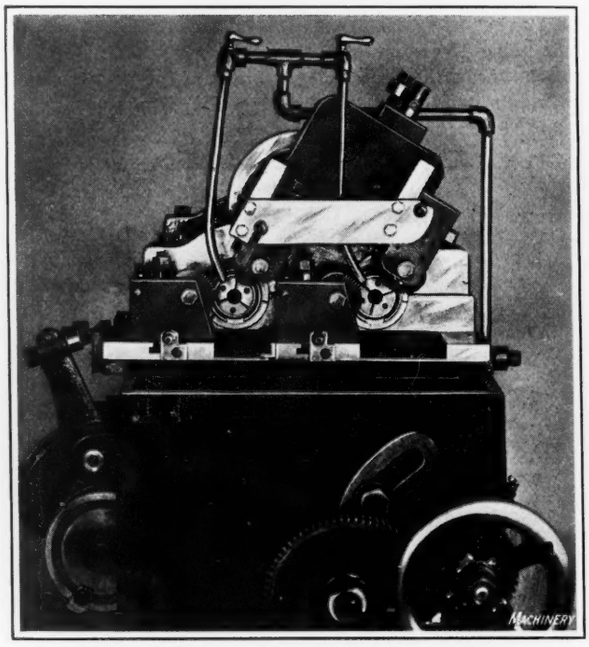


Fig. 2. Close-up View of Automatic Forming Machine showing Arrangement of the Two Work-spindles

The two spindles are placed side by side, and the duplicate sets of forming and cutting-off tools work together on two bars of stock so that two pieces are completed in the length of time that would be required for making one on a single-spindle machine. The tooling and setting-up of the machine can be accomplished quickly as a result of the adjustments provided in all directions. The members through which adjustments are obtained are graduated for the convenience of the operator. The rigidity of the machine enables heavy cuts to be taken at high speeds without vibration, and all parts are amply proportioned for strength and longevity. Simplicity was the keynote in designing the machine.

The spindles are hardened, ground, and lapped, and run in phosphor-bronze boxes provided with means of compensating for wear. Thrust is taken up at the rear end of each spindle by hardened steel and phosphor-bronze bushings. The spindles are driven from the shaft of a three-step cone pulley through spiral gearing, which is entirely enclosed and runs in oil. The pulley shaft is provided with roller bearings. Six changes of spindle speed in geometrical progression ranging from 240 to 1820 revolutions per minute are obtainable. The chucks are easily changed; they are adjusted by a nut at the rear end of each spindle, and are prevented from moving endwise when opening or closing.

The feeding mechanism is controlled by adjustable dogs conveniently located. It feeds the work rapidly in any length up to 3 inches, but by the use of extra dogs, lengths up to about 12 inches can be fed. The feeding may be accomplished at any time during the revolution of the camshaft. The forming tools are carried on cross-slides, and can be adjusted independently in any direction. The slides on which the cutting-off tools are mounted are set at an angle to provide clearance between the tools. These tools can be adjusted independently or in unison. Change-gears supplied with the machine enable a production of from 60 to 1800 pieces per hour, the rate, of course, depending upon the character and size of the part. The machine occupies a floor space 44 inches long and 26 inches wide.

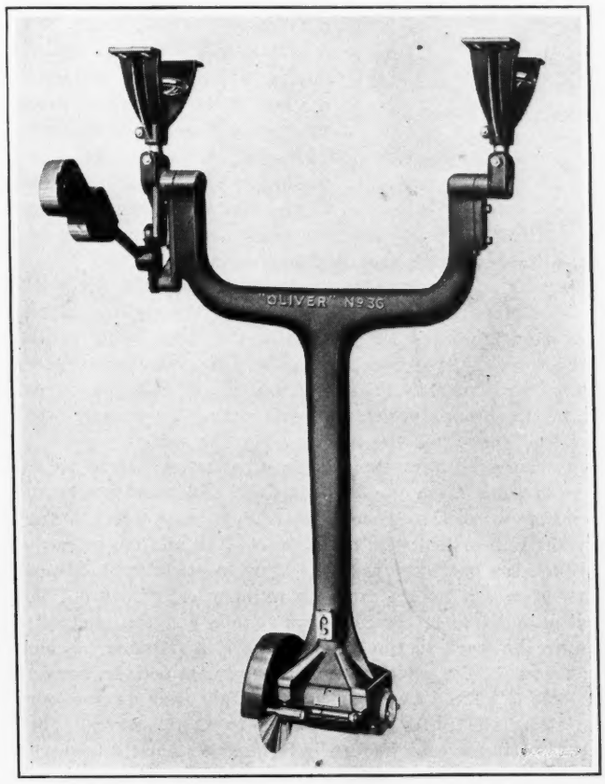
OLIVER SWING CUT-OFF SAW

A swing cut-off saw which may be driven either by belt or by a motor directly mounted on the saw arbor has been placed on the market by the Oliver Machinery Co., Grand Rapids, Mich. The motor-driven type is shown in the illustration, from which it will be seen that the push-buttons used to control its operation are conveniently located directly above the motor. The motor-driven arrangement is supplied only for two- or three-phase, 60-cycle, 220- or 440-volt, alternating current. The motor is of 3-horsepower capacity, and operates at 3600 revolutions per minute. A 16-inch diameter saw is fitted to the end of the saw arbor when the machine is motor-driven, and an 18-inch saw when it is belt-driven.

The frame is a cored casting with a single arm centrally located. The arbor unit is attached at the lower end of the frame by a tongue and groove connection. The frame is made in three standard lengths, 5 feet 5 inches, 7 feet 5

inches, and 9 feet 5 inches, respectively. The saw arbor is made of crucible steel and machine-ground to size. It is mounted in two self-oiling split bearings, and has a speed of 2000 revolutions per minute. The arbor frame is detachable from the main frame, and is adjustable vertically for taking up the stretch of the belt on belt-driven machines. A handle is bolted to the arbor frame for the convenience of the operator.

The saw is equipped with a counterbalance consisting of weights on a lever which tend to reduce the resistance of the equipment to the operator. On the belt-driven style, a



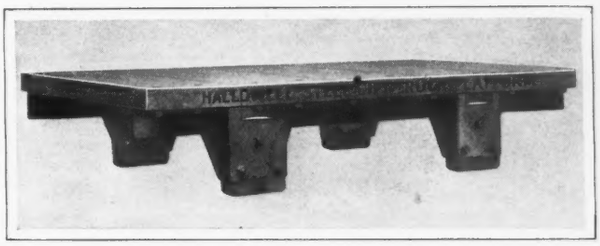
No. 36 Swing Cut-off Saw made in Motor- and Belt-driven Types by the Oliver Machinery Co.

countershaft extends between the bearings of the frame at the top, and a belt from one of the countershaft pulleys extends through the hollow arm of the main frame to connect with a pulley mounted on the saw arbor in place of the motor. June, 1921, MACHINERY contained a description of a table designed especially for use with a saw of the type described in this article, this table also being manufactured by the Oliver Machinery Co.

MILLERSBURG HELICAL-FLUTE EXPANSION HAND REAMER

The helical-flute expansion hand reamer here illustrated has recently been placed on the market by the Millersburg Reamer & Tool Co., Millersburg, Pa. The cutting action of the teeth is said to be such that chatter is eliminated, and smooth and accurately sized holes are produced. A patent covering the construction of this expansion hand reamer has been applied for. It is made in various sizes.

Helical-flute Expansion Hand Reamer made by the Millersburg Reamer & Tool Co.



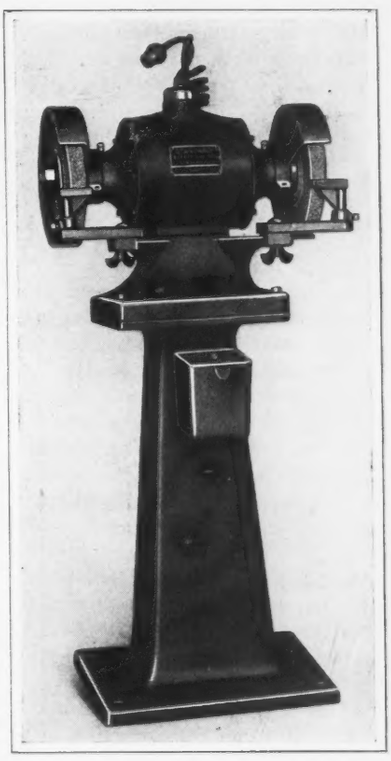
Steel-and-Wood Lift-truck Platform made by the Standard Pressed Steel Co.

"HALLOWELL" LIFT-TRUCK PLATFORM

A platform which may be adapted for use with either hand or power lift trucks is now being manufactured by the Standard Pressed Steel Co., Jenkintown, Pa., as shown in the accompanying illustration. The platform consists of wooden planks to the bottom of which are bolted two steel skids. Riveted to these skids are four steel brackets in each of which a wooden leg-block is bolted to support the entire platform. These blocks can be replaced as they become worn, and are made in different heights so that the clear height of a platform may be changed to suit the truck with which it is employed. An important feature of the skids is that they flare in an outward direction at each end, thus enabling a truck to be readily slid between them. There are also no projecting rivet- or bolt-heads or nuts that might come in contact with the truck.

BENCH AND FLOOR TYPE ELECTRIC GRINDER

A ½-horsepower alternating-current electric grinder of an improved type is now being manufactured by the Standard Electric Tool Co., Cincinnati, Ohio, in a bench style which may also be provided with a pedestal as illustrated. The grinder is fitted with double-row ball bearings and a Westinghouse motor suitable for operation on either 110- or 220-volt, single-, two-, or three-phase alternating current. The grinding wheels are 8 inches in diameter, ¾ inch in face width, and have a ⅝-inch hole. They are extended well away from the body of the motor to permit the grinding of comparatively long and irregular castings or bars. One coarse and one fine wheel are regularly furnished, the former being intended for castings and rough work, and the latter for tools and fine work. A quick make-and-break switch is located on top of the motor, in which position it is within easy reach of the operator. Ten feet of reinforced cord fitted with a plug is regularly furnished. The net weight of the grinder without a floor pedestal is about 110 pounds, and with a pedestal 225 pounds.



Grinder built by the Standard Electric Tool Co.

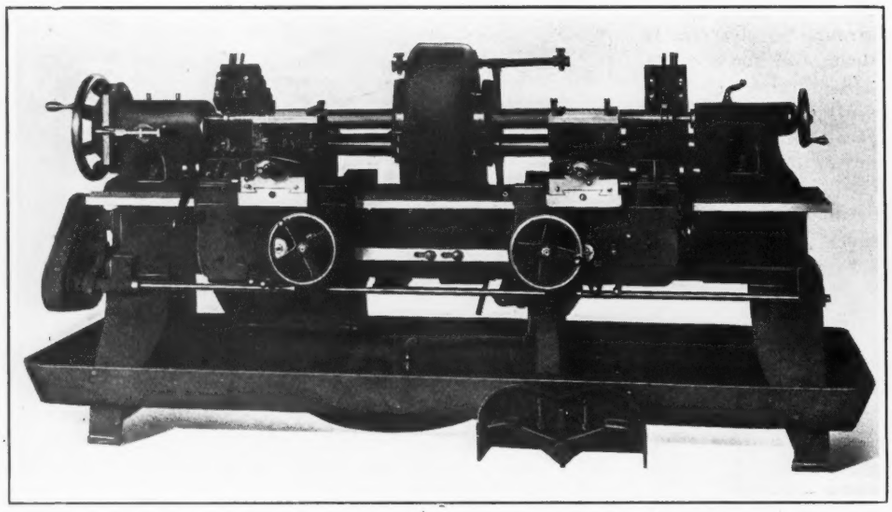


Fig. 1. Short-head Center-drive Lathe of an Improved Type built by the Reed-Prentice Co.

REED-PRENTICE CENTER-DRIVE LATHE

A lathe driven at the center, which was designed by the Reed-Prentice Co., 677 Cambridge St., Worcester, Mass., for turning both ends of Ford automobile driving shafts was described in an article published in May, 1918, MACHINERY. Another machine in which the same driving principle is employed has recently been built by this concern as shown in the accompanying illustrations. However, a considerable number of changes have been made in the general design. This class of machine has proved useful for turning both ends of axles and similar parts, the one limitation on such work being that the part to be machined cannot be turned at the middle portion, because it is held in the headstock at that point.

The headstock is equipped with two chucks, one at each end of the spindle, which are generally of the floating type. These position themselves relative to the outside diameter of the work when the jaws are tightened, at which time the chucks are securely clamped against shoulders on the spindle. By means of this construction the work is held rigidly, is positively driven, and maintains its natural position without deflection. In cases where the work is particularly short, one chuck is omitted to permit the carriages to come closer to the headstock.

The spindle is made of cast iron, has a large hole running its entire length, and rotates in cast-iron journals. It is driven by a motor of at least 7½ horsepower, which is mounted at the rear of the bed as shown in Fig. 2, and drives direct through a silent chain to a sprocket gear on the spindle. The driving mechanism is controlled by a foot-treadle at the front of the machine by means of which a clutch is actuated to engage or disengage the gearing to the headstock without stopping or starting the motor.

The left-hand tailstock has an extra large spindle with two holes running through its entire length, one of these holes being for the purpose of carrying a standard center, while the other is a clearance hole through which the work is telescoped in loading and unloading the machine. By withdrawing the index-plunger at the front of this tailstock, its spindle may be revolved to bring the clearance hole into proper alignment with the hole in the headstock spindle, after which work may be entered or withdrawn from the headstock. When work has been placed on the machine, the index-plunger is again released and the spindle rotated to bring the center once more into proper position for supporting the left end of the work. The withdrawal of the index-plunger is effected through the rotation of a large handwheel, there being a certain angle of free rotation during which a cam surface on the hub of the handwheel causes the plunger to be withdrawn. Then by continuing to rotate the handwheel the plunger picks up the motion and finally brings the center or the clearance hole into alignment with the headstock spindle.

There is no endwise adjustment for the spindle of the left-hand tailstock; however, the spindle of the right-hand tailstock may be moved longitudinally, the latter being similar to the standard type used on engine lathes. Either tailstock may be unclamped from the bed and moved along this member to the proper position to suit longer or shorter work than that for which the machine may be set.

The carriages have their bridges set off center to permit them to work close to the headstock, and their blocks are arranged to receive special magazine tool-holders. Each carriage is provided with an eccentric link motion, by means of which the operator feeds the tools to predetermined positions, at which points they are automatically locked. The longitudinal feed of the carriages is then engaged, and after turning the work to the desired length, a tripping mechanism automatically releases the link and cam actions, causing the tools to recede from the work so that they do not score the latter when they are returned to their starting positions. Each carriage has an individual automatic feed-trip, although they are both driven by a single set of feed gearing at the left-hand end of the machine. Both carriages feed simultaneously toward the headstock. On the particular machine illustrated, a back-arm attachment has been supplied for each carriage, so that the squaring of shoulders as well as the grooving of shaft ends can be performed simultaneously with the turning operation.

Several set-ups possible with this machine are as follows: (1) The machine may be arranged with front tool-blocks for diameter turning and rear blocks for shoulder and taper

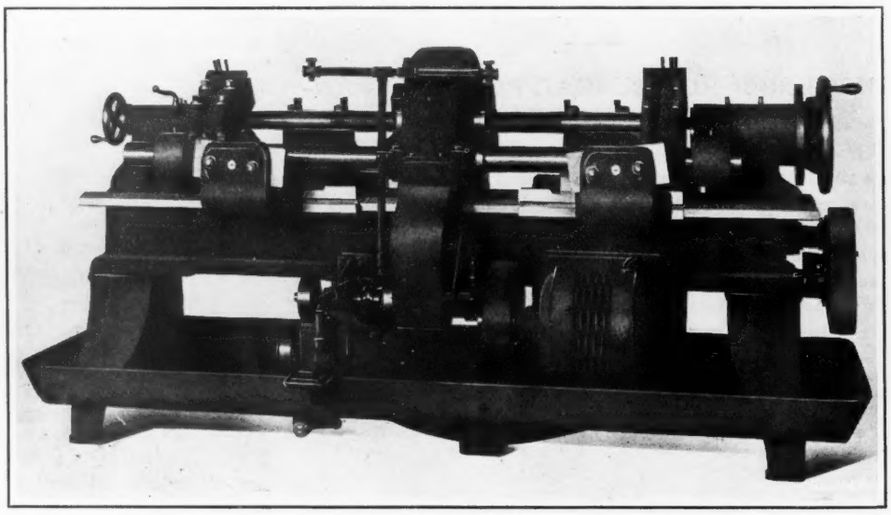
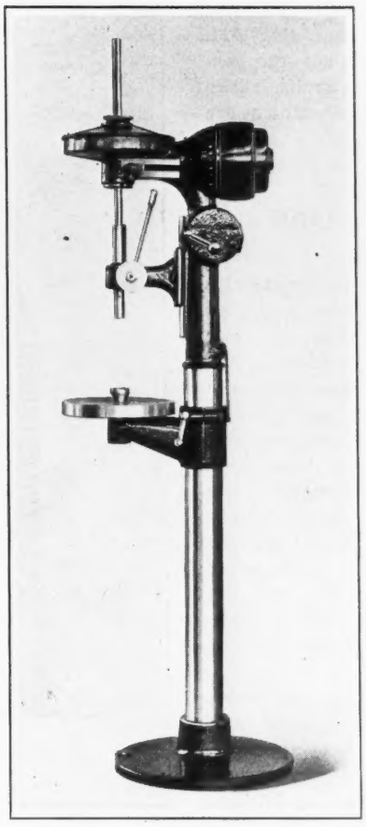


Fig. 2. Rear View of the Machine illustrated in Fig. 1 which is employed for turning the Ends of Shafts, Axles, etc.

turning, the rear blocks being brought into position by hand after the diameter turning has been accomplished; (2) front tool-blocks may be supplied for diameter turning, and a back arm for use in shouldering, necking, chamfering or grooving simultaneously with the turning step; (3) auxiliary hand-operated tool-blocks may be introduced at the rear for shaving fillets or chamfering corners. On a machine designed for turning shafts up to 2⅞ inches in diameter and having a 9-foot bed, the maximum distance between centers is 72 inches.

LOUISVILLE SENSITIVE DRILLING MACHINE

A 12-inch sensitive drilling machine equipped with friction drive to which power is transmitted by a motor built into the top of a column is a recent product of the Louisville Electric Mfg. Co., Louisville, Ky., which is here illustrated. The motor rotor and the friction disk are mounted on ball bearings. The frictional pressure of the drive is governed by the weight of the disk, thus being constant and requiring no adjustment. The friction drive members are completely enclosed and so constructed that their frictional surfaces are kept free from oil. The spindle is counterbalanced by means of a spring, and its speed can be easily adjusted from 450 to 1200 revolutions per minute. The table is also counterbalanced by a weight within the column. The motor can be furnished for all circuits. Its controlling switch is also built into the machine.



Twelve-inch Motor-driven Sensitive Drilling Machine produced by the Louisville Electric Mfg. Co.

This drilling machine is made in both bench and floor types and supplied with V-blocks and cup and point centers. Some of its main dimensions are as follows: Greatest distance from table to nose of spindle, 39 inches; vertical adjustment of table, 32 inches; vertical adjustment of spindle arm, 8 inches; maximum height with spindle raised, 76 inches; diameter of spindle in sleeve, 13/16 inch; and diameter of table, 11½ inches. The spindle socket is a No. 3 Morse taper. The motor runs at a speed of 1725 revolutions per minute, and has a rating of ½ horsepower.

PRATT & WHITNEY GAGES

A set of automobile engine spark-plug thread gages made to S. A. E. standard limits and consisting of a double-end limit thread plug gage of the "Trilock" reversible-end type, a "Go" and "Not Go" templet gage, and a setting plug gage for the templet which has two threaded plug members and one plain plug for checking its root diameter is illustrated in Fig. 1. This gage set is now being introduced to the trade by the Pratt & Whitney Co., Hartford, Conn. The pitch diameters of the thread plugs are 0.841 and 0.843 inch, respectively, the tolerance for tapped holes being 0.002 inch. The templet pitch diameters are 0.836 and 0.839 inch, respectively, giving a 0.003-inch tolerance on the spark-plug body threads and a neutral zone of 0.002 inch between a maximum size plug and a minimum size hole.

The templet is of an improved type having a taper screw permitting fine adjustment of the pitch diameter. The "Go" and "Not Go" holes are located close together for convenience in placing on work and in handling. The "Go" side of the templet is cut away to permit a quick identification when using the gage in rapid inspection.

September, 1921, MACHINERY contained an illustrated description of a line of plain and thread plug gages made by the Pratt & Whitney Co., which had reversible ends held securely to the handle by means of three prongs on this member and corresponding grooves on the gage ends. The plain style was made in sizes from 5/16 to 2 inches. Fig. 2 of the present article shows a plain plug gage of similar type but which is made in sizes of 2½ inches and larger. As will be seen in the broken detail, the gage ends consist of a hollow ring into which two disks are forced on tapered surfaces before grinding. These disks hold a central tube, and the entire end is secured to the handle by means of a washer and a machine screw. Three prongs on the handle are forced into corresponding grooves in the bushing to provide the three-point self-centering support embodied in the design of the gages referred to in the previous article. The "Trus-

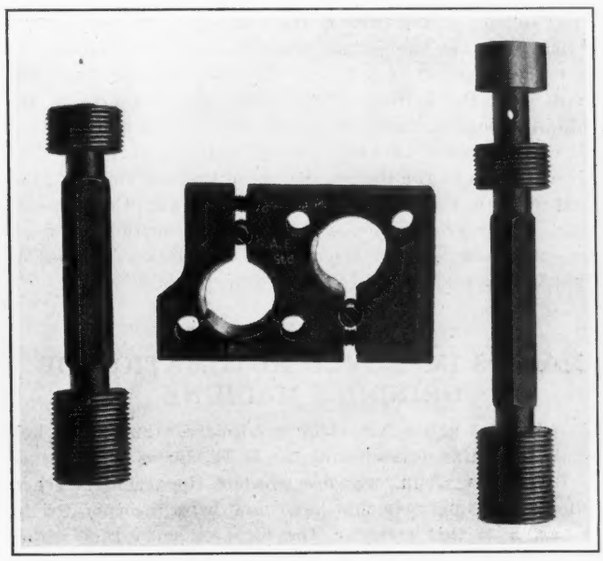


Fig. 1. Automobile Engine Spark-plug Thread Gage Set made by the Pratt & Whitney Co.

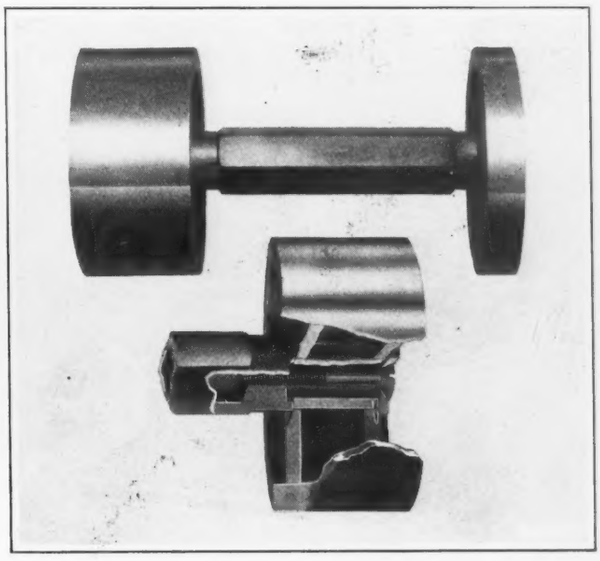


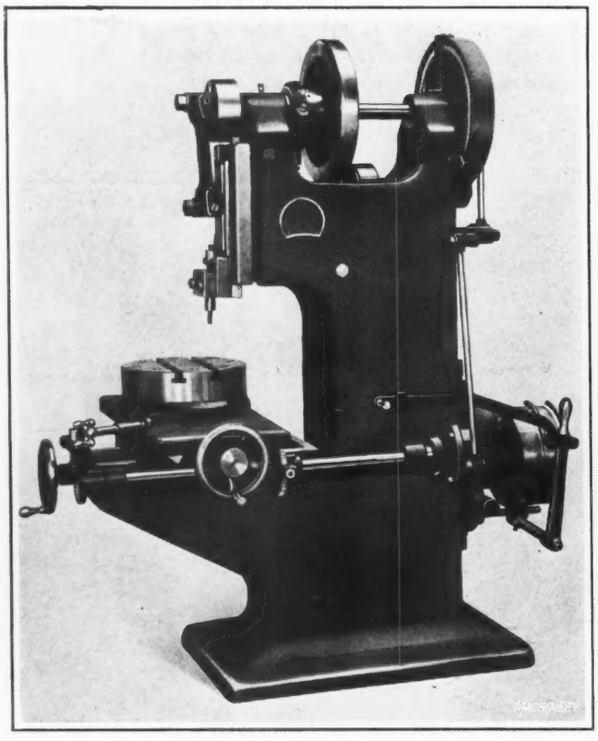
Fig. 2. Hollow- and Reversible-end Plain Plug Gage made in 2½-inch and Larger Sizes

form" adjustable-limit snap gages also manufactured by the Pratt & Whitney Company were described in July, 1921, MACHINERY. These gages were constructed along the general lines of a roof truss and had round-head anvils. They may now be obtained with square-head anvils which are interchangeable with the round-head type.

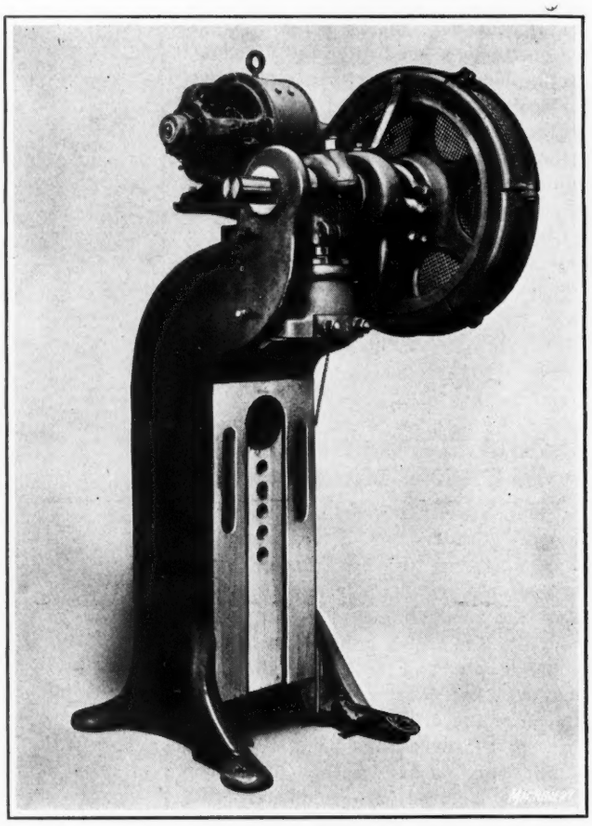
PETERS-BOSSERT DIE-SLOTTING MACHINE

A vertical slotting machine designed especially for machining round, square, and irregular shaped punches and dies has been recently developed by the Peters-Bossert Co., 617-619 E. Pearl St., Cincinnati, Ohio. As will be noted in the illustration, the ram is driven by a crank connected at the upper end to a crankpin on the main shaft at the top of the machine. This crankpin is adjustable so that any length of stroke up to 4 inches may be obtained. The member on which the ram slides, and to which it is gibbed, is hinged at the upper end in such a manner that it can be set at a slight angle relative to the face of the column in order to produce a clearance in die openings. The crank-arm at the lower end is attached to a pin located in a slot in the ram, the position of this pin being adjustable in order that the location of the ram path may be altered to suit the work in hand.

The lower end of the member on which the ram slides may be connected by the manipulation of a pull-pin to a toggle-joint mechanism operated by an eccentric on the main shaft. When connected, this mechanism moves the ram over a curved path on the down stroke, thus enabling curved cuts to be taken in dies. The mechanism also causes the tools to clear the cut on the up stroke, the amount of clearance being adjustable to suit requirements. When the toggle-joint mechanism is disconnected, the machine is set for taking straight cuts. Cross, longitudinal, and circular hand feeds of the work are each obtained through separate screws, but the machine can also be furnished with power feeds when these are desirable. A variable-speed gear-box mounted inside the column furnishes three changes of speed, which may be secured by shifting a lever on the outside of the column. The machine is supplied with tight and loose pulleys.



Vertical Die-slotting Machine built by the Peters-Bossert Co.



Special Horning Press built by the Ferracute Machine Co.

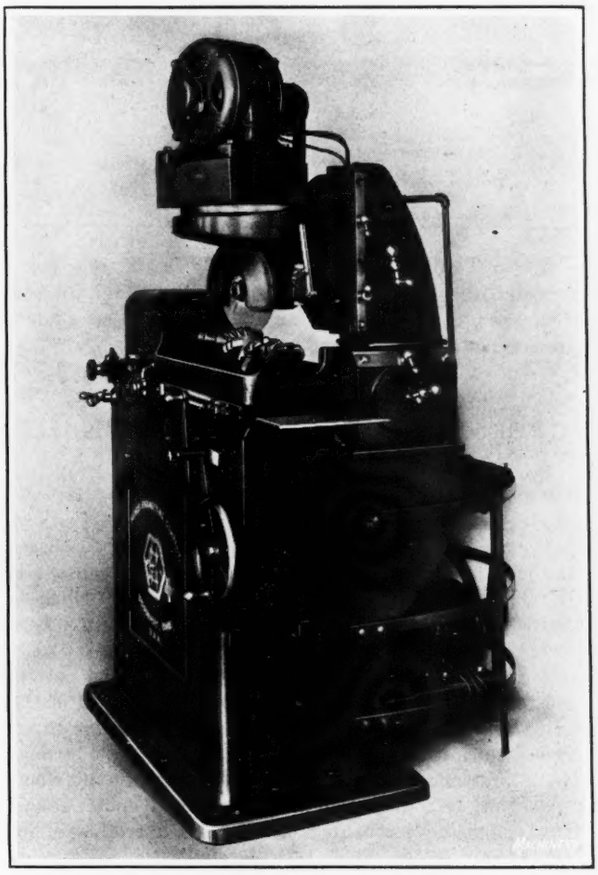
FERRACUTE MOTOR-DRIVEN HORNING PRESS

The Ferracute Machine Co., Bridgeton, N. J., has recently produced the special horning press illustrated herewith, which is driven by a motor mounted on a bracket bolted to the frame. The motor drives the press through a rawhide pinion which meshes with teeth cut around the flywheel. This method of driving is especially advantageous, as it is out of the way and economical as regards space. The flywheel is entirely surrounded by a guard, and, in addition, has wire mesh cast between its spokes so as to prevent any possibility of accidents when the press is in motion.

The hole provided in the frame for the horn is 7½ inches in diameter and located 43 inches above the floor. This is unusually high, but the press is intended for special work. The horizontal distance from the center of the ram to the planed surface on the front of the frame is 11 inches. Guides are machined on the planed front to enable an adjustable bed to be attached at different heights from the floor and square with the bottom of the ram. The connections are made by means of large bolts and dowels in a manner that insures parallelism between the bed and ram surfaces. The wide variation in the distance between the bed and the ram, together with the facilities for horning and the unusual height of the press, provide for a greater latitude of work than is customary with machines of this class. Presses of this design are also made in four other sizes.

HARRIS IMPROVED AUTOMATIC HOB GRINDING MACHINE

A few years ago a No. 815M motor-driven automatic hob grinding machine developed by the H. E. Harris Engineering Co., Bridgeport, Conn., was described in the technical press. A number of improvements have now been incorporated in the design of this machine, the more important of which will be enumerated in the following. The improved style is about 20 per cent heavier than the older machine, and



Hob Grinding Machine redesigned by the H. E. Harris Engineering Co.

the motor drive for the reciprocating parts is mounted on an integral bracket at the back of the machine instead of being placed on the floor as formerly. This new arrangement makes the machine self-contained. The maximum helix angle to which an 8-inch diameter hob can be ground has been increased to 47 degrees, in both right- and left-hand hobs.

In the old design, a sliding block was used to transmit the spiral action from an adjustable angular slide-way at the back of the machine, but ball bearings are now employed for this purpose. Heavy bronze bushings of oil-well construction, with a positive adjustment for wear are now supplied for the wheel-spindle. The overhang of the table from the bed of the machine at the end of its stroke has been decreased, the column is made heavier at the back, and the slides are longer. The overhang of the wheel has also been reduced to insure rigidity. The index-head is provided with larger bearings and has been redesigned so that, except for the heaviest hobs, it is unnecessary to support the outer end of the work-arbor by means of the tail-stock center. This possibility saves considerable time in changing from one hob to another.

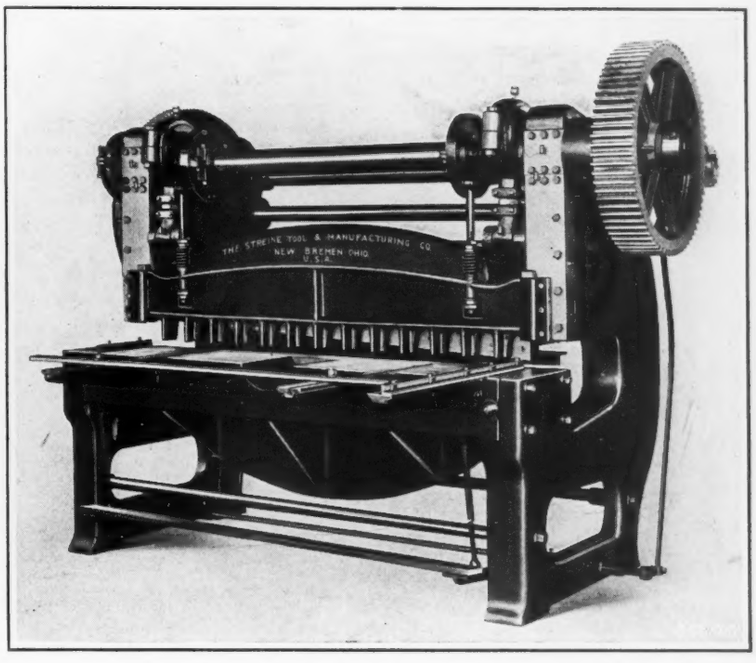
The arrangement for wet grinding has also been changed, larger valves and pipes and a deeper pan now being supplied so that about double the amount of the coolant can be used. The machine can be quickly set not only for radially grinding the faces of hob teeth but also to compensate for wear of the wheel. An adjustment provides for grinding hobs under-cut or with "hook" or top rake for the teeth. An improvement made in the arrangement of the control members enables all adjustments to be made by the operator while in position at the front of the machine. The majority of these adjustments can be made while the machine is running. The diamond truing device is now built into the head instead of being located on the work-table. The latter is driven by a clutch and gear mechanism connecting to a pinion meshing with a rack. Stops on the front of the table permit adjustments to suit the grinding of hobs of any length within the capacity of the machine.

STREINE GAP SHEAR

A newly designed shear having a gap in the housings which facilitates the splitting of long plates has been added to the line of shearing machinery built by the Streine Tool & Mfg. Co., New Bremen, Ohio. The illustration shows a 6-foot machine, but the same design is built in other lengths. It has a capacity for cutting annealed steel up to $\frac{3}{8}$ inch in thickness. One of the features to which attention is particularly directed is the design of the cutter-bar, or, as it is commonly called, the cross-head. This cutter-bar is of double- and cross-ribbed box construction, and provided with long bearings fitted into the slides of the housings by means of adjustable hand-scraped taper gibs.

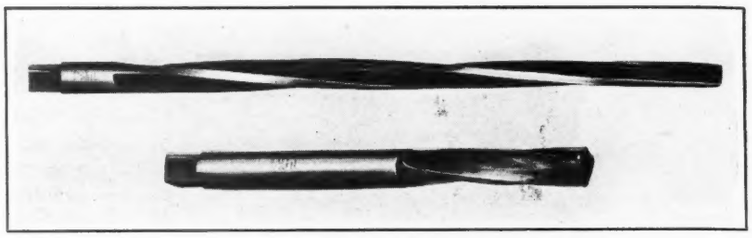
This construction obviates the necessity of providing a truss rod or some other similar device to keep the cutter-bar from springing or deflecting under strains. The long bearings by which the cutter-bar is attached to the housings, as previously mentioned, prevent the bar from tilting while cutting, and so enable sheets to be cut with a clean smooth edge. The cutter-bar is connected to the eccentrics by means of adjustable links; with this construction the shear knives may be set, by raising or lowering the cutter-bar, either to split long stock or to do plain shearing to the full length of the knives.

The eccentrics are double-keyed and shrunk on the eccentric shaft. The bearings of this shaft are split and can be readily adjusted or replaced. All shafts are of large diameter and all gears machine cut, the gears being made of semi-steel castings and the pinions of steel forgings. The clutch is also made of forged steel and fitted with a tool-steel clutch pin and finger. The hold-down or clamp is automatically operated and equipped with compensating springs to take care of unevenness of variation in the thickness of metal to be sheared. The bed of the machine can be adjusted to suit the requirements of the work.



One of a New Line of Gap Shears manufactured by the Streine Tool & Mfg. Co.

A full set of front, side, and back gages is furnished, the back gage being of the parallel-screw and miter-gear operated type which is manipulated through a crank handle. The miter shaft is made in two pieces joined by means of a sleeve. This sleeve can be loosened and the gage set parallel with the blades or otherwise in a minimum amount of time. Parallel graduations in sixteenths of an inch are marked from the edge of the shear blades to the ends of the front gage supports to enable the operator to set the gages quickly and accurately. This shear can also be arranged with a motor drive and equipped with a long squaring arm. Some of the specifications of the size illustrated are as follows: Length of shear blades, 74 inches; size of flywheel pulley, 42 by 7 inches; speed of flywheel pulley, 280 revolutions per minute; strokes of cutter-bar, 18 per minute; and ratio of gearing, 16 to 1.



Two "Cutwell" Reamers made by the Bickford-Switzer Co.

BICKFORD-SWITZER HELICAL-FLUTED REAMERS

The Bickford-Switzer Co., 50 Norwood St., Greenfield, Mass., is now manufacturing a line of "Cutwell" reamers, two of which are here illustrated. The taper pin reamer at the top of the illustration has three right-hand helical flutes on which the cutting lands are rugged and the hook or undercut generous. Two of the lands are relieved right up to the cutting edge, while the third land is relieved for only about two-thirds of its width, the remainder being a circular section which steadies the reamer and prevents the right-hand spirals and under-cuts from drawing the tool into the work. This reamer seems to work at its best in a drilling machine, and when used for cutting steel, the chips look like steel wool.

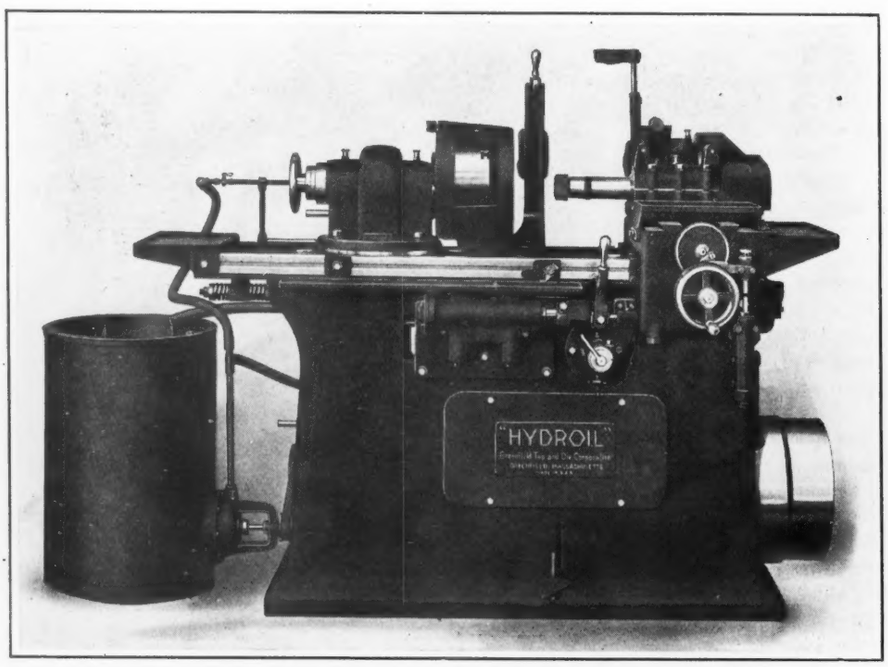
The principal claims made for this reamer are that it will not draw into the work, does not chatter, cuts similarly to a drill, and works best when used under power. The same principle of design has been applied to a chucking or hand reamer for straight holes, one of which is shown in the lower part of the illustration. In this case the reamer is made with three equally spaced and fully relieved cutting lands, and midway between two of these is a narrow and unrelieved land which steadies the reamer and keeps it from being drawn into the hole or chattering. It also serves, in connection with one of the cutting edges, to furnish a place for conveniently measuring the reamer diameter.

GREENFIELD "HYDROIL" INTERNAL GRINDING MACHINE

A new internal grinding machine known as the "Hydroil" has been brought out by the Greenfield Tap & Die Corporation, Greenfield, Mass. The design of this machine is based on the principle of high traverse speeds. The wheel-spindle is carried on a slide controlled by a feed-screw which is calibrated for feed increments of 0.004 inch on the bore diameter of the work. The work-table reciprocates on ways located at right angles to the wheel-slide ways and carries a head for holding and rotating the work. The speed of the table traverse is controlled through a highly sensitive throttle valve, which admits oil under low pressure to a distributing valve controlled by table limit stops. From the distributing valve, oil is conveyed to either end of a double-acting cylinder-and-piston mechanism attached to a cross-head on the under side of the table. By the application of the hydraulic principle a flexibility of table control can be obtained which it is impossible to secure by mechanical means. The regular machine has a maximum speed of 50 feet per minute, although special designs provide for faster operation.

With the "Hydroil" control there are no definite stations of speed setting, and so minute differences of speed may be obtained without difficulty. The valve and piston designs provide for reversal of the table without shock, and the element of time involved in accomplishing a reversal is so small that on a ½-inch stroke the table will reverse 320 times per minute. A pressure-relief valve permits the table to stop without damage when overloaded. This feature also allows accurate positioning of the table for grinding against shoulders. A screw-adjusted stop is employed to locate the table, after which this member is held in place under oil pressure. By a combined use of reversing and locating stops, the table can be held to within limits of 0.0005 inch on reversal, without any sacrifice in the operating speed.

All table motions are controlled by a single lever. By pulling this lever toward the operator, the table is run back from the operating position. Another movement of the lever brings the table up to the operating position, where it automatically reciprocates between the working limit stops. A foot-treadle is employed to start and stop rotation of the work. The work revolves toward the operator at the top, the wheel turning in the opposite direction.



Internal Grinding Machine developed by the Greenfield Tap & Die Corporation, on which the Table Traverse Speeds are controlled by a Hydraulic Arrangement

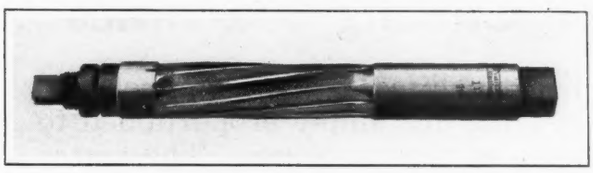
The truing diamond contacts on the back of the wheel and so throws the dust downward. The fixture of the diamond-holder swings out of the way, but it may be quickly located in the truing position. Water is supplied for cooling the diamond.

The spindle bearing pressures are in the same direction whether the wheel is grinding or running free. The spindles provided on the standard machine are mounted in ball bearings so installed that a thrust adjustment eliminates vibration. Where an exceptional mirror finish is desired, the production rates are sacrificed to some extent, and special types of spindles are furnished. However, high operating speeds may be employed to advantage even in this class of work. The machine is especially suitable for removing stock rapidly in roughing operations. With holes three inches or more in diameter, at least one cubic inch of hardened steel can be removed per minute.

A special type of work-head is provided for large bearing races having straight holes. This head chucks several races end-to-end and holds them between a plunger operated by oil pressure and a mechanism similar to a camera shutter. The plunger ejects the load at the completion of an operation. By the use of loading pots this fixture may also be employed in grinding piston-rings and similar parts, a machine equipped in this manner having a capacity for grinding about 25,000 piston-rings per ten-hour day.

PRATT & WHITNEY HELICAL-FLUTED EXPANSION REAMER

A recent addition to the line of small tools manufactured by the Pratt & Whitney Co., Hartford, Conn., is the helical-fluted expansion hand reamer here illustrated. Its adjustable feature enables one size to cover a range of diameters,

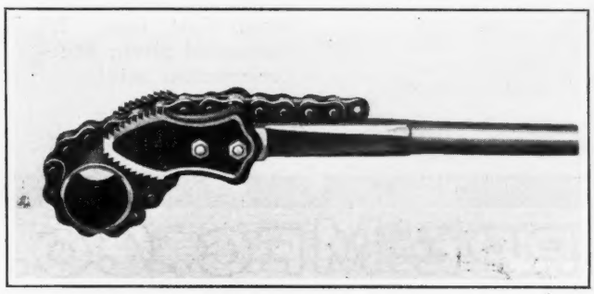


Hand Reamer of the Helical-flute Expansion Type made by the Pratt & Whitney Co.

it being possible to ream over- or under-size holes after making a simple adjustment. The reamer is equipped with a lock-nut to hold it to an adjusted size, and a safety stop which prevents over-expansion and indicates positively when the maximum limit is reached. The reamer is made in all regular sizes.

ARMSTRONG CHAIN PIPE WRENCH

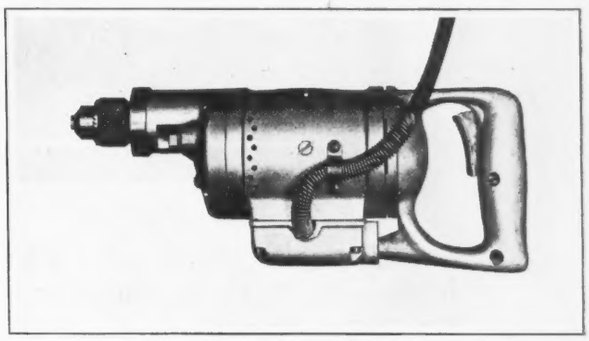
A chain pipe wrench having two drop-forged jaws and a length of either flat-link or cable chain is now being manufactured in seven sizes for pipes ranging from ⅛ to 16 inches, by the Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. The wrench shown in the illustration is provided with a flat-link chain. Through the use of hardened chrome-nickel steel bolts, the jaws are held solidly in place, the rear bolt being located directly under the chain socket where the strains tending to spread the jaws are most severe. Chain guides are provided on the jaws to protect the finished end of the bar from wear due to the action of the chain and to make the adjustment of the chain convenient. The handle is forged from high-carbon steel.



Flat-link Chain Pipe Wrench made by the Armstrong Bros. Tool Co.

"WILLEY" PORTABLE ELECTRIC DRILL

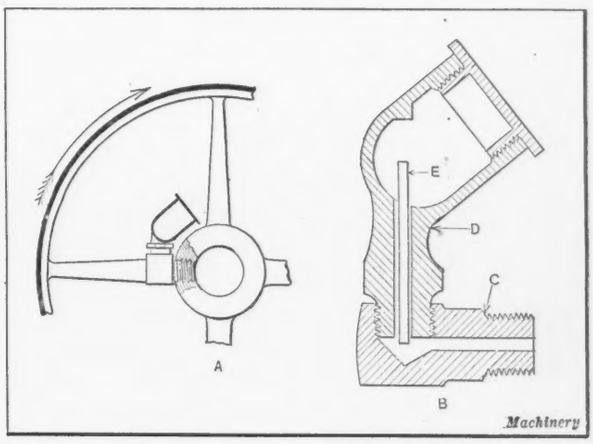
Under the trade name of "Willey" the James Clark, Jr., Electric Co., Inc., 522 W. Main St., Louisville, Ky., is placing on the market a portable electric drill made in 3/16-, ¼-, and 5/16-inch sizes, weighing 6½, 7 and 7¾ pounds, respectively. The drill is constructed of three units, consisting of the motor body, the drill spindle and gears, and the handle. The latter is provided with a mechanism for controlling the motor switch, which is actuated by the fingers of the operator in grasping the handle. By this arrangement the drill automatically stops rotating when hand pressure is released from the switch mechanism. All electrical connections and attachments are contained in the motor body. The tool is designed for use with high-speed drills only when drilling in steel or iron, it being intended that carbon-steel drills be used for the softer metals and wood.



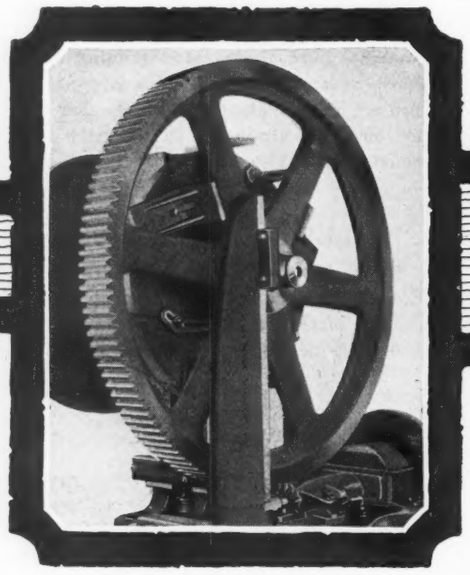
Portable Electric Drill made by the James Clark, Jr., Electric Co., Inc.

KAY LOOSE-PULLEY OIL-CUP

To accomplish the efficient and economical oiling of loose pulleys, Charles Kay, 5073 Burns Ave., Detroit, Mich., has brought out an oil-cup which is said to keep the pulley shaft well oiled while the pulley is revolving and does not allow the oil to empty from the cup and leak along the bearings when the pulley is stationary and the oil-cup is above the shaft center. The method of mounting the oil-cup on the hub of the pulley is shown at *A*, while the detail at *B* clearly illustrates the construction of the cup. The fitting *C*,



Loose-pulley Oil-cup manufactured by Charles Kay

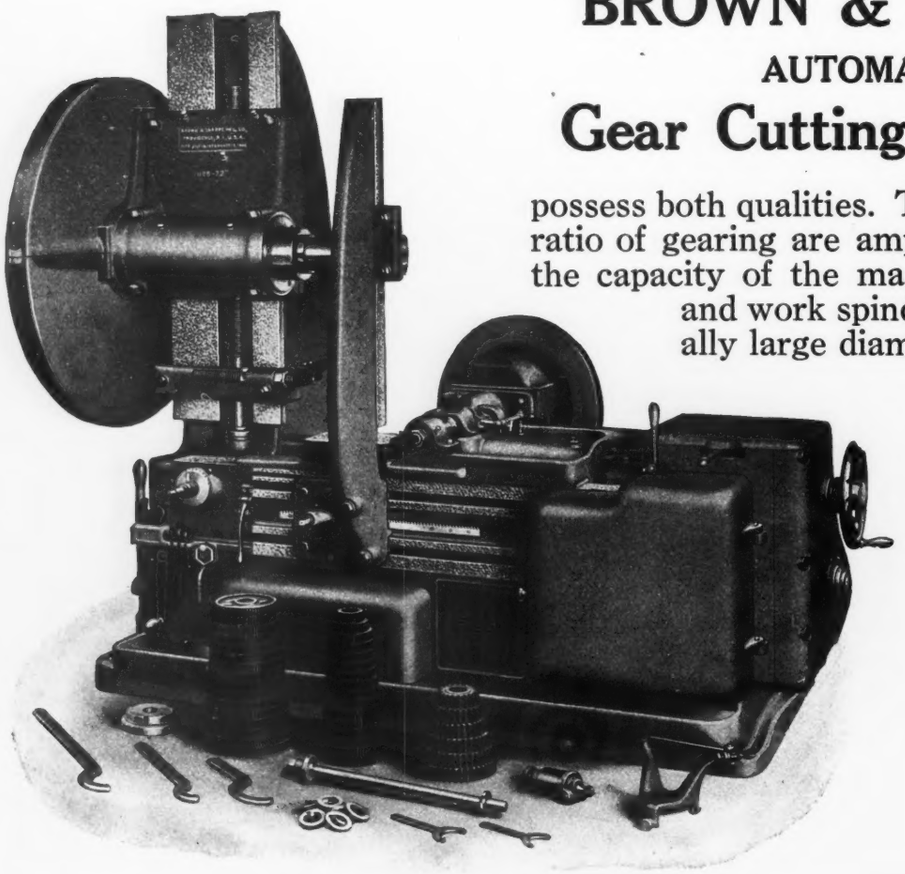


BROWN & SHARPE
AUTOMATIC GEAR

For Cutting Gears with

When specifications call for the cutting of large, heavy gears, as shown in the illustrations, the machine used must be one which will stand up under the strain of heavy work and produce accurate gears.

BROWN & SHARPE
AUTOMATIC
Gear Cutting Machines

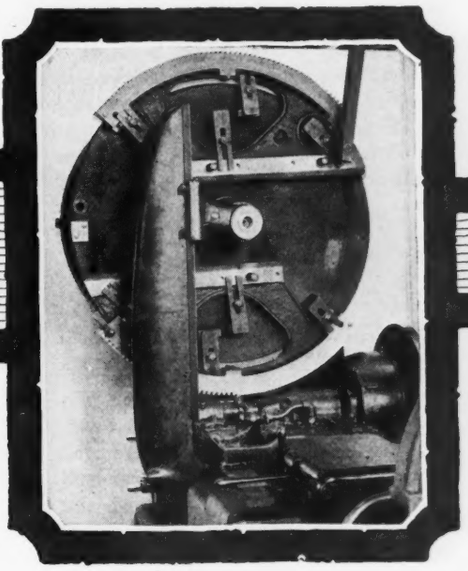


possess both qualities. The driving belt and ratio of gearing are amply proportioned to the capacity of the machines. The cutter and work spindle are of exceptionally large diameter and the heavy balance wheel on the cutter spindle prevents chattering and maintains uniform cutting action.

Capacity No. 6 Machine, Spur Gears to 72 in. diameter, 13 in. face; Cast iron, 1¾ diametral pitch; Steel, 2 diametral pitch.

BROWN & SHARPE MFG. CO.

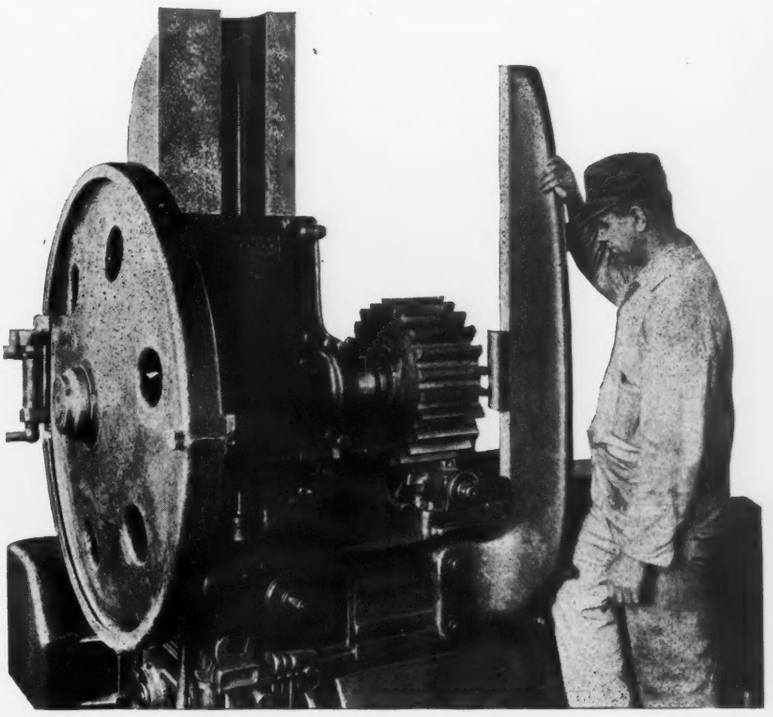
SHARPE
CUTTING MACHINES



Large, Heavy Accuracy

The accuracy with which these machines function is due primarily to their sturdy construction features. The substantial base and the one piece bed and upright, with heavy internal ribbing, furnish a rugged support and prevent vibrations that would impair the accuracy of the finished product. This rigid construction eliminates destructive chatter and permits utilizing fast feeds and high speeds.

The indexing mechanism starts and stops without shock and is locked positively for each tooth space. In addition, the index wheel is of large diameter and keyed to the work spindle, which further reduces the possibility of any inaccuracy in spacing.



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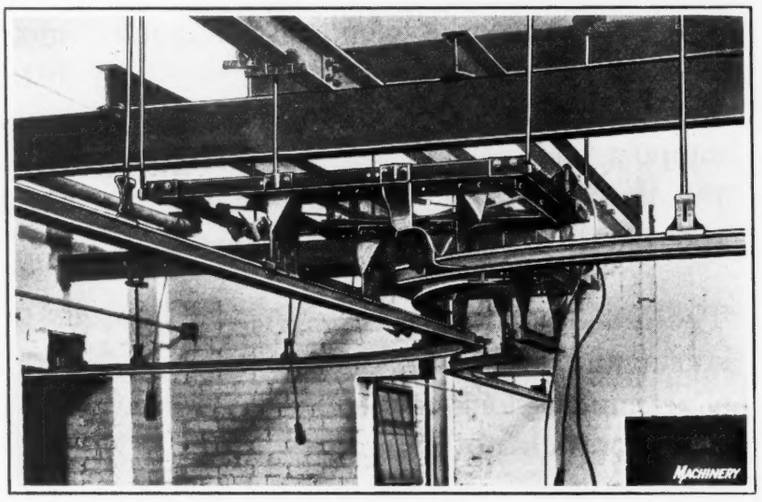
PROVIDENCE, R. I. U. S. A.

which has a hole drilled along its center line, is screwed into a hole that is tapped in the hub of the pulley, and the shank of oil-cup *D* is screwed into a tapped hole in fitting *C*. It will be seen that the hollow portion of the cup is at an angle to the shank, and that a sliding pin *E* is placed in a passageway through the shank. This pin has a movement in the passageway that is limited at one end by the pin striking against a lug on the wall of the cup, and at the other end by the pin coming in contact with fitting *C*. The pin is only moved when the pulley is started or stopped, serving to keep the passageway unobstructed and to regulate the flow of oil.

CLEVELAND TRAMRAIL OVERHEAD CARRYING SYSTEM

To reduce the time required for moving work from machine to machine and about the shop, the Cleveland Crane & Engineering Co., Wickliffe, Ohio, has developed a tramrail overhead carrying system in which the carrier may be operated by hand or electric power and the rail of which can be bent to a 4-foot radius so that practically all machines or locations in a shop can be reached. The rails are made of a special analysis high-carbon steel which can be bent cold on the job and are of a light section. The fittings employed in connection with the rail have been standardized to meet any requirements likely to be met with in wooden, structural or concrete buildings, and to permit the rail to be erected by the workmen of the plant in which an installation is made.

With the sliding switches furnished with this system, it is impossible for a carrier to run off the rail at an open switch, because of the provision of a safety stop which drops on the rail. The switches are locked in the closed position to prevent a carrier and its load from sliding the switch out of position. An additional safety feature can be added to make it impossible for an electrically driven carrier to run at full speed against a safety stop. This involves the use of trolley insulators which provide a dead section of the trolley wire that is energized only when the switch is in position to receive a carrier. Electrically driven carriers have ample power to carry a full load up a 12½ per cent grade.



Tramrail Carrying System developed by the Cleveland Crane & Engineering Co.

NEW MACHINERY AND TOOLS NOTES

Surface Grinding Machine: Badger Tool Co., Beloit, Wis. A surface grinding machine of the vertical-spindle type, which is equipped with a steel disk wheel, 42 inches in diameter, faced with a special abrasive compound, ½ inch thick. The machine is direct motor-driven, the shaft of the motor serving as the spindle of the machine. This machine is particularly adapted for grinding such parts as large tractor transmission cases and covers.

Spindle-type Grinding and Sanding Machine: Wonder Grinder Co., 612 W. 12th St., Erie, Pa. An internal grinding and sanding machine applicable to both wood and metal parts. The work-holding table is circular and can be tilted 45 degrees either side of the horizontal. It is automatically locked in position at right angles to the spindle. The spindle or roll for carrying the abrasive is mounted on a vertical shaft and driven directly from a vertical motor mounted in the base.

Hydraulic Forcing Press: Watson-Stillman Co., 192 Fulton St., New York City. A hydraulic press intended especially for forcing, pressing, and bending operations in railroad and large machine shops. The press is of the reversed cylinder type. The pump is employed only to actually apply the pressure, a handwheel being used to quickly bring the ram to and from the work. The pressure in pounds per square inch on the ram and also the total pressure in tons are indicated on a gage.

Burners, Furnaces, and Forges: Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago, Ill. A line of burners, furnaces, and forges for general shop use, including high-pressure, high- and low-pressure, and intermediate-pressure burners; a portable oil-burning rivet forge which employs compressed air for atomization; an oil-fired furnace designed for use in tempering punches, dies, tools, and knives; a crucible furnace employing either gas or oil as fuel and intended for use in lead or cyanide hardening, soft metal-melting, tinning baths, and galvanizing; a forge for use in welding and miscellaneous forging work; and a furnace for handling large forging work.

* * *

NEW BOOK ON PRODUCTION MILLING

PRODUCTION MILLING. By Edward K. Hammond. 278 pages, 6 by 9 inches; 177 illustrations. Published by THE INDUSTRIAL PRESS, 140-148 Lafayette St., New York City. Price, $3.

Recent years have witnessed the introduction of many improved methods of performing milling operations. On production work, where high rates of output are essential, the aim has been to reduce the non-productive time of the men and machines in the milling department. In the preparation of this treatise, attention has been given to methods of milling and the design of fixtures that will enable repetition operations to be performed economically. Information and illustrations relating to the latest developments in production milling practice have been gathered by personal studies of the methods used in many of the most progressive manufacturing plants; and acknowledgement is made to the large number of factory executives who have cooperated in this work. All the methods described have been successfully used under actual shop conditions.

It has been assumed that the readers of this book are familiar with the various types of production milling machines. Hence, only brief descriptions of the essential features of each type of machine have been included. It is the purpose of this book to explain the application of some of the more efficient methods of operating milling machines on repetition work, rather than to discuss milling machine design. In connection with the examples of machining operations performed on the various types of milling machines, information is included covering the speed and feed at which each operation is performed and the rate of production that is obtained. These data should prove of value to other manufacturers handling similar work. No attempt has been made to deal with work-holding fixture design, beyond explaining certain fundamental principles which must be observed in order to keep the ratio between the "loading time" and the "cutting time" down to a point where satisfactory rates of output can be secured.

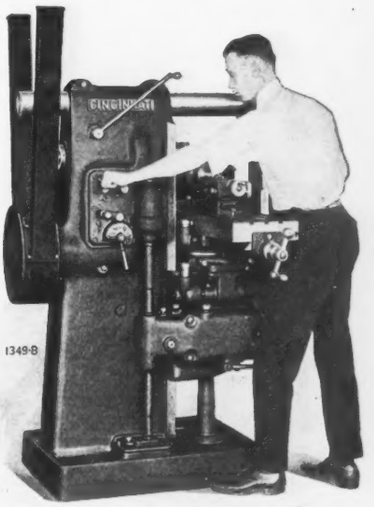
Who would expect it of a Universal?

The Cincinnati 1M and 2M Universals will take the same heavy cuts with the same quiet ease as the 1M and 2M Plains.

But more important is the story of the picture below. The toolmaker easily reaches the starting lever. The feed changes are at his finger tips. Feed changes are made while running. The feed trip is arranged to permit engagement of the feed forward or reverse without running off the dogs by hand. All controlled without leaving his seat.

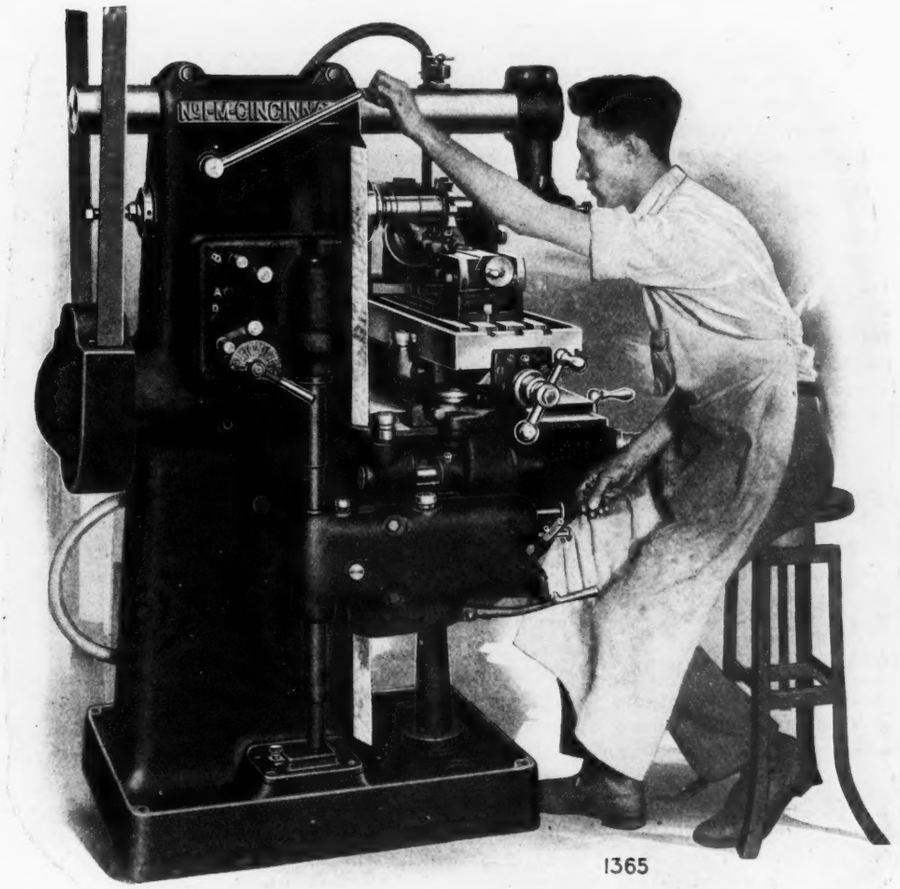
Do you know of any other Universal Miller that is so handy?

These are only a few of the good things in the Cincinnati. The catalog tells about all of them. Shall we send it?



The speed change levers can be reached from the operator's usual position. The belt is guarded 6 feet above floor. This meets the usual factory safety requirements.

Cincinnati 1M and 2M Universals



The Cincinnati Milling Machine Company
Cincinnati, Ohio
U. S. A.

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, January 12

THE present outlook in the machine tool trade is encouraging. An effective stabilizing influence is the withdrawal of the 12½ per cent bonuses, effective January 1, which was referred to in the December article, as selling prices can now be calculated on a definite wage basis.

Demand for Machine Tools

There is a fair demand for certain classes of machine tools, for example, planers, punching and shearing machines, and three-operation automatics, and a few orders are being received from industries that have not been in the market for many months. Firms who make a specialty of tooling equipment and manufacturers of small tools report a slight improvement in the market, although naturally the actual amount of business is much below full capacity.

The continued disposal of surplus government stocks at prices that often are actually less than scrap value has led the Machine Tool Trades Association to send a committee to the Disposals Board with certain proposals, among which is the suggestion that the Government hold its stocks until any small demand there may be at the present time has been satisfied direct from the maker to the user and more normal conditions obtain. It is believed that there is some prospect that these proposals will be put into effect.

Conditions in the Automobile Industry

The automobile exhibition held at Olympia was of considerable importance from many points of view, as not only were the first real post-war designs in evidence, but the amount of business done came as a surprise to everyone. There are instances of makers whose whole output for 1922 has been spoken for. One large manufacturer is said to have disposed of cars to the value of over three million pounds, and it is anticipated that this particular firm will produce over ten thousand cars during the present year. The automobile manufacturers are beginning to take on additional help, and there is contemplation of an increase in the number of working hours.

As the automobile factories have represented, in the past, an average of as much as 50 per cent of the domestic trade of the machine tool maker, this revival of the automobile industry is of considerable importance. Automobile works are generally well equipped with machinery, but there are instances in which new equipment will be required to complete work started at the beginning of the general trade depression, but which has been held up until conditions should improve. Both Colonial and Continental markets are displaying great interest in buying, and inquiries have been received for machine tools and accessories, particularly from Australia and Czecho-Slovakia.

Iron and Steel Trade

In the iron and steel trades, British makers continue to receive their full share of orders. Costs are being reduced and a general expansion of business is hoped for. In all but a few instances British iron and steel makers are now offering their products at prices which successfully meet foreign competition, and substantial orders have been the result of this reduction in prices. British iron and steel makers are also finding it easier to obtain orders in the home market, although most buyers still find it necessary to limit their orders strictly to those called for by immediate needs. A feature of the general situation, which is basic to recovery in the machine-building trades, is the gradual improvement of the British output in pig iron. At the end of October there were eighty-two blast furnaces in operation, as compared with sixty-eight at the end of September. While Continental competition is still being experienced, the situation shows signs of improving, especially in view of the slight fall in transportation rates and fuel prices.

Whatever the ultimate advantage gained by the withdrawal of the orders for battleships, as the result of the negotiations that have taken place in Washington, there has been little short of consternation at the tentative suspension of work, and the iron and steel industry has felt the effect in common with the engineering and shipbuilding trades. Forging plants that were reopening in order to cope with the requirements of shipbuilders have again had to close down.

Exports and Imports

The overseas trade in machine tools during November shows some improvement over the previous month. The total value of exports rose to over £175,000 for a tonnage of 1250. The imports again are low, amounting to only a little over £18,000 for a tonnage of 112. The exports of small tools were valued at £44,000. Over £64,000 of the export value was represented by lathes, of which 197 were shipped to the overseas markets. More than £49,000 worth of the heavier type of metal-working machinery, such as bar-cutting and plate bending machines, steam hammers, ingot cropping and swaging machines were exported, while drilling machines, planing and shaping machines, and grinding machines were imported and exported in about equal quantities.

It seems likely that the year 1921 will show a total export of about 1¼ times pre-war exports in tons. Taken as a whole, imports are slightly below the pre-war level, so that the ratio of exports to imports has considerably improved, as compared with pre-war trade, the ratios being approximately 3 to 1 in 1914, and 4 to 1 at present. The export trade also shows signs of improvement in other lines besides machine tools.

Materials and Prices

Overseas buyers are generally taking more interest in the materials market, and, although orders are spasmodic, business of fair proportion is being done. The difficulty of obtaining reasonable delivery from Continental works increases, and the general opinion is that France, Belgium, and Germany are unlikely to be able to improve upon the situation in this respect for some time. Arrangements as to minimum prices fixed by the Scottish and English Tool Makers Association have been terminated, and a return has been made to the pre-war competitive system. It is expected that this will lead to the placing of orders which have been held in abeyance.

Compared with a month ago, the prices of most raw materials show a further decline. Pig iron generally has dropped 15s per ton, and finished steel also shows a drop of from 20 to 30s per ton. Castings are quoted at substantially lower prices than have prevailed for a considerable time; thus 16-inch lathe castings are now offered at 20 to 25s per hundredweight, and the lighter grades at 28s per hundredweight. Reeled bars have again dropped considerably, the price of £14 10s prevailing a month ago being now down to £12 10s.

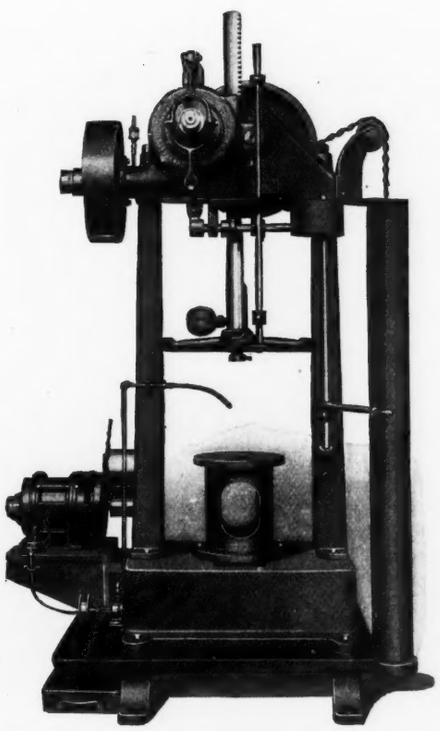
ANNOUNCEMENT

SOMETHING NEW

Yet tested and tried

The Lucas Vertical Push-Broaching Machine

(A modification of the Lucas Power Forcing Press)



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Has been in successful operation for over two years on *vertical push-broaching* and *production assembling.*

ADVANTAGES:

Shorter, and therefore less expensive broaches.
Better lubrication of cutting edges.
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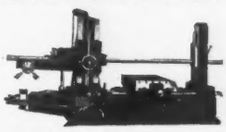

BORING, DRILLING AND MILLING MACHINE

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

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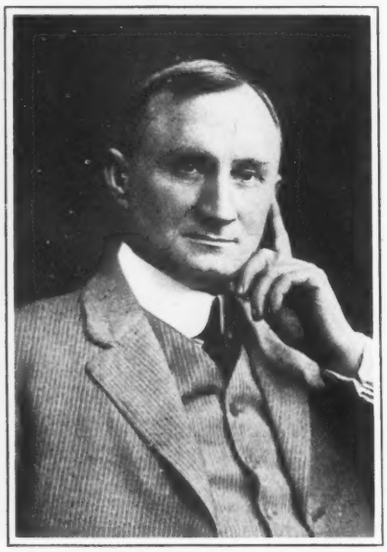
OBITUARIES

JAMES A. BRADY, who was president and general manager of the James A. Brady Foundry Co., Chicago, Ill., up to the time of his retirement about ten years ago, died January 9, age seventy-four years. At the age of twenty-five he became connected with the foundry business at Beaver Falls, Pa., and in 1899 organized the James A. Brady Foundry Co. in Chicago.

GEORGE BALDWIN SELDEN, inventor of the first gasoline-propelled vehicle and a pioneer in the automotive industry, died in Rochester, N. Y., January 17, aged seventy-seven years. Mr. Selden was president of the Selden Motor Co., of Rochester. He was graduated from Yale University in 1869 and later studied law, being admitted to the bar in 1871. Most of his legal work was in connection with patent legislation. Mr. Selden made his first gasoline driven engine in 1873.

T. C. DILL

T. C. DILL, president of the T. C. Dill Machine Co., Inc., Philadelphia, Pa., died suddenly on January 6 from heart failure, at the age of fifty-seven. Mr. Dill was well known in the machine tool industry, the slotting machine which bears his name being widely used in machine shops throughout the country. He founded the T. C. Dill Machine Co. in 1888 for the manufacture and sale of the Dill slotter. Prior to patenting his slotter, he had manufactured and marketed a connecting-rod, but the slotter business grew so rapidly that it became necessary to devote the entire efforts of the organization to this line. This growth of the slotter business was due largely to the efforts of Mr. Dill in developing a machine with unusual features, embodying the traveling head, which is the most striking feature of the Dill machine. These slotters are particularly well known in railway shops, and Mr. Dill's name will long be remembered in this field as well as in the machine-building industries in general, not only because of his mechanical achievements but also because of his attractive personality. The business will be continued by his widow, Mrs. Matilda J. Dill, who will become president of the company. His daughter, Mrs. Matilda Dill Moore, has been the company's secretary for several years.



THOMAS P. EGAN

THOMAS P. EGAN, president of the J. A. Fay & Egan Co., Cincinnati, Ohio, manufacturer of woodworking machinery, died January 10 at the Good Samaritan Hospital in Cincinnati, after a long illness. Mr. Egan was born in Ireland in 1848. Early in his life his family emigrated to Canada, where he obtained employment for a time. Later he came to the United States, going directly to Cincinnati and was naturalized there. Starting his career as a lathe hand in the employ of Steptoe, McFarland & Co., of Cincinnati, he rose to a position of leadership in the machine tool industry. The accidental loss of his arm caused him to be transferred from the shop to the office, where he advanced quickly and made a remarkable record as a salesman. In 1874 he went into the woodworking machinery business, and a few years later organized the Egan Co. which was consolidated in 1893 with the J. A. Fay Co. under the name of J. A. Fay & Egan Co. The firm grew steadily until it is now the largest woodworking machinery plant in the country. He was one of the founders of the National Association of Manufacturers and its first president, and when the association held its twenty-fifth annual meeting in New York a year ago, Mr. Egan was guest of honor. He is survived by his widow and seven children.

PERSONALS

DANIEL CUSHING, metallurgical engineer of Boston, Mass., has moved from 40 Court St. into larger quarters at 50 Congress St.

H. P. LOSELY, formerly industrial engineer with the James E. Morrison Co., Detroit, Mich., has gone into business for himself, having opened an office as industrial engineer at 414 Peter Smith Bldg., Detroit, Mich.

W. H. PATTERSON, who has been associated with the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., for the last sixteen years has become vice-president of the Kaestner & Hecht Co., Chicago, Ill., electric elevator builder.

ARTHUR JACKSON, engineering representative of the Potter & Johnston Machine Co. in Japan, has been elected a regular member of the Japan Society of Mechanical Engineers. During the war Mr. Jackson was demonstrating Gridley automatics in Great Britain.

GEORGE C. KIMMEL has resigned as mechanical engineer from the Cincinnati Grinder Co., Cincinnati, Ohio. Mr. Kimmel had been connected with this company since its inception in 1910 and previous to that was associated with the Heald Machine Co. and the Norton Co.

W. B. WACHTLER, until recently manager of the Chicago district for the Industrial Bearings Division of the Hyatt Roller Bearing Co., has been promoted and transferred to the New York headquarters of the division at 709 Sixth Ave., as engineer in charge of general applications.

W. O. RENKIN has become associated with the Hardinge Co., Inc., 120 Broadway, New York City, in the capacity of managing engineer of the Quigley pulverized fuel department, since this department of the Quigley Furnace Specialties Co. has been acquired by the Hardinge Co., Inc.

W. D. BLATZ has been appointed general sales manager of the Bridgeport Brass Co., Bridgeport, Conn. Mr. Blatz joined the selling organization of the company in 1915, and during his connection with the company has made a thorough study of the brass industry in all its various branches, having traveled extensively.

A. H. BAUMAN has been elected vice-president and director of the Cleveland Duplex Machinery Co., Cleveland, Ohio. Mr. Bauman was formerly general foreman of the Gun Division of the American Brake Shoe Works, Erie, Pa. For the last three years he has been associated with the Cleveland Duplex Machinery Co. as sales engineer.

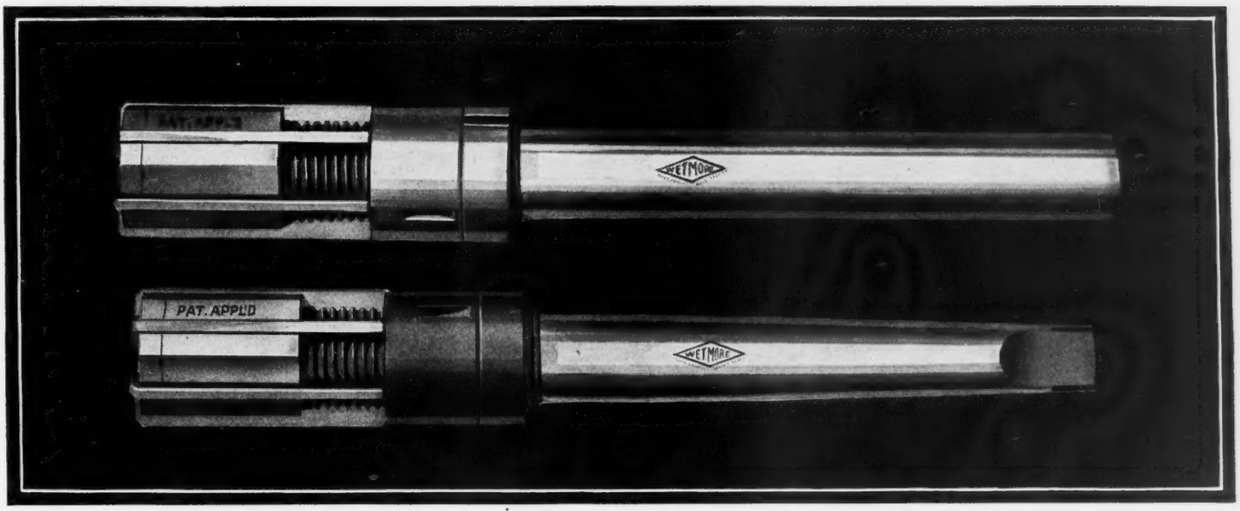
O. M. RAU, formerly consulting engineer to the Philadelphia Rapid Transit Co., has now become associated with the Hardinge Co., Inc., 120 Broadway, New York City, and will specialize in the handling of Quigley pulverized fuel systems as applied to boilers. This change took place with the acquirement by the Hardinge Co., Inc., of the pulverized fuel department of the Quigley Furnace Specialties Co.

JAMES E. GLEASON of the Gleason Works, Rochester, N. Y., was installed as president of the Chamber of Commerce of Rochester at a meeting of the Chamber on January 16. The principal speaker at the annual dinner, given in connection with the meeting, was Henry J. Allen, governor of Kansas who addressed the Chamber on the Kansas Industrial Court. A large number of factory foremen, who had been invited to attend, were present.

ZENO D. BARNS has been appointed manager of the Cleveland office of the Ajax Metal Co., Philadelphia, Pa., to fill the vacancy made by the death of Louis E. Purnell. The Cleveland office, which is located at 429 Schofield Bldg., takes care of the business in the states of Ohio and Michigan. Mr. Barns has been connected with the Westinghouse Electric & Mfg. Co., and the Westinghouse Air Brake Co for some years past.

* * *

The University of Illinois maintains a number of research graduate assistantships in the Engineering Experiment Station to assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering. These assistantships, for each of which there is an annual allowance of $600, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. An appointment is made for two years, and upon the satisfactory completion of the work, the degree of Master of Science is conferred. There are now several vacancies to be filled, and applications should be sent to the director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.



Wetmore Expanding Machine Reamers

—*In Sizes Under One Inch*

NOW—for the first time—manufacturers and other users of precision tools can obtain expanding machine reamers of guaranteed quality and accuracy *in sizes under one-inch.*

These new Wetmore Expanding Small Machine Reamers range in size by thirty-seconds from 5/8" to 31/32", inclusive—both straight and taper shank. They are *guaranteed* in every detail and are designed to meet the exacting requirements of quantity-production, high-speed work. In expanding these small reamers, there are no unnecessary screws to be loosened, because the expansion is taken care of by a cone nut and lock nut in rear of blades. The straight blades are held securely by a special method, exclusive to Wetmore Expanding Reamers.

These Wetmore "little fellows" typify the high standards of workmanship and materials that have made Wetmores *standard* in so many of America's largest plants. Here are some of the advantages of the general line of Wetmore Expanding Reamers:

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made. Cone expansion nut keeps blades always parallel with axis.

Solid, heat-treated alloy steel body—guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering, and scoring of the reamer while backing out.

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If you are now using Wetmore Expanding Reamers, you will gladly welcome the Small Machine Reamers illustrated above. If you are not using Wetmores, you should have a copy of our new 1922 Catalog—just printed. It is a valuable "hand-book" on expanding reamers and cylinder reaming sets. Write for your copy today—your request places you under no obligation.

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Manufacturers of Expanding Reamers and Cylinder Reaming Sets, Arbors and Thread Gauges.

We have some territory open for district representatives. Write for details of our attractive proposition.

WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

COMING EVENTS

February 13—Winter meeting of the American Boiler Manufacturers' Association at the Fort Pitt Hotel, Pittsburg, Pa. Secretary and treasurer, H. N. Covell, 191 Dikeman St., Brooklyn, N. Y.

February 14—Meeting of the Engineering Society of Buffalo at the Iroquois Hotel, Buffalo, N. Y. Secretary, N. L. Nussbaumer, 80 W. Genesee St., Buffalo.

February 20-25—Spring meeting of the American Institute of Mining and Metallurgical Engineers in the Engineering Societies' Bldg., New York City. Secretary, Frederick F. Sharpless, 29 W. 39th St., New York City.

February 22—Conference of practicing engineers under the auspices of the American Association of Engineers, in Chicago, Ill.; headquarters, Congress Hotel. Public information service of the American Association of Engineers, 63 E. Adams St., Chicago.

February 27-March 10—British industries fair in London and Birmingham, organized by the Department of Overseas Trade. Address of secretary for London, 35 Old Queen St., London, S.W. 1. Address of secretary for Birmingham, Chamber of Commerce, 95 New St., Birmingham. Further information can be obtained from the British Consulate General in New York City.

April 19-20—Annual meeting of the National Metal Trades Association in New York City; headquarters, Hotel Astor. Secretary, Homer D. Sayre, Peoples' Gas Bldg., Chicago, Ill.

April 22-May 2—Sixth annual Swiss sample fair at Basle, Switzerland, in the Great Exhibition Bldg. For further information apply to F. Dossenbach, Director of the Official Information Bureau of Switzerland, 241 Fifth Ave., New York City.

April 24-29—Annual convention and exhibit of the American Foundrymen's Association in Cleveland, Ohio; headquarters, Cleveland Public Hall, Lakeside Ave. and E. 9th St. Secretary, C. E. Hoyt, 140 S. Dearborn St., Chicago, Ill.

May 8-11—Spring meeting of the American Society of Mechanical Engineers in Atlanta, Ga. Assistant Secretary (Meetings), C. E. Davies, 29 W. 39th St., New York City.

June 26-July 1—Twenty-fifth annual meeting of the American Society for Testing Materials in Atlantic City, N. J.; headquarters, Chalfonte-Haddon Hall Hotel. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

NEW BOOKS AND PAMPHLETS

Fifth Biennial Report of the Department of Labor and Industry of the State of Maine for 1919-1920. 159 pages, 6 by 9 inches. Published by the Department of Labor and Industry, Augusta, Maine.

Structure and Related Properties of Metals. 104 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 113 of the Bureau of Standards. Price, 25 cents.

Twenty-fourth Annual Report of the Bureau of Labor and Industrial Statistics of the State of Virginia for 1921. 139 pages, 6 by 9 inches; 10 charts. Published by the Bureau of Labor and Industrial Statistics, Richmond, Va.

The Distribution of the Forms of Sulphur in the Coal Bed. By H. F. Yancey and Thomas Fraser. 94 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 125.

Annual Report of the Director of the Bureau of Foreign and Domestic Commerce to the Secretary of Commerce for the Fiscal Year ended June 30, 1921. 148 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C.

NEW CATALOGUES AND CIRCULARS

Bausch & Lomb Optical Co., Rochester, N. Y. Price list of microscopes, microtomes, and accessories, effective January 2.

Whitman & Barnes Mfg. Co., Akron, Ohio, manufacturer of twist drills and reamers, is distributing a calendar for 1922 to the trade.

Wagner Electric Mfg. Co., St. Louis, Mo. Bulletin 129, descriptive of the main features of the new Wagner polyphase motor known as the "Pow-R-full."

Goulds Mfg. Co., Seneca Falls, N. Y. Bulletin 123, descriptive of Goulds steam turbine driven centrifugal pumps, for use in paper mills, textile mills, steam power plants, mines, etc.

Rockford Milling Machine Co., Rockford, Ill., has recently issued complete circulars describing cutters, collets, arbors, and small tools, for use in connection with Rockford milling machines.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Leaflet 1825, illustrating and describing applications of the arc-welding process for repair and reclamation work as well as for manufacturing processes.

Carrier Engineering Corporation, 750 Frelinghuysen Ave., Newark, N. J., is issuing a monthly publication known as the "Weather Vein," containing information relating to air conditioning, drying equipment, etc.

Holophane Glass Co., Inc., 342 Madison Ave., New York City. Bulletin 343, descriptive of the Holophane lightmeter, which is a portable instrument designed for the accurate measuring of light and for color matching.

Weimer Machine Works Co., Lebanon, Pa. Circular, 12½ by 11 inches, containing full-page illustrations of Weimer patent cinder cars, styles J and K, which may be operated either by hand power, steam, air, or electricity.

Ohio Cultivator Co., Bellevue, Ohio. Pamphlet descriptive of the Ohio automatic belt-power baling press, for use in salvage departments for handling all classes of compressible materials, including the lighter gages of sheet metals.

Hydraulic Press Mfg. Co., Mount Gilead, Ohio. Catalogue 43-B, covering the H-P-M line of hydraulic high-pressure valves and fittings. The pamphlet contains sixty-four pages of illustrations, descriptions, and tabular material. In addition to the standard line of valves a few special types are shown.

Wardwell Mfg. Co., Cleveland, Ohio. Catalogue of machinery and tools for sharpening woodworking and metal-cutting saws. Illustrations and data are given covering band-saw filing, setting, and jointing machines; band-saw grinders; lap grinders; circular saw setters and filers; circular saw grinders, etc.

Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio. Bulletin 1016A, containing description, illustrations and tables of ratings for E. C. & M. automatic motor starters for non-reversing direct-current motors. New price lists have also been issued by the company effective December, 1921, covering E. C. & M. apparatus.

V & O Press Co., Glendale, Long Island, N. Y. Bulletin 6-B, containing illustrations and brief descriptions of automatic feeding attachments for power presses, including standard single- and double-roll feeds, grip feeds, and dial feeds. The illustrations show the wide field of application for which these attachments are adapted.

Union Switch & Signal Co., Swissvale, Pa. Pamphlet entitled "Forging Ahead," containing a large number of illustrations of typical forgings produced by this concern. A brief statement is made of the equipment and capacity of the concern, and a chart is included giving S.A.E. steel specifications and recommended heat-treatments for the steels listed.

General Electric Co., Rock Drill Department, Fort Wayne, Ind. Circular 68980 illustrating and describing the boom mounting designed by the company for the Fort Wayne electric rock drill, which is designed for installation on mine cars, to take the place of the tripod type of mounting and to reduce the manual labor of handling the drill to the minimum.

Arthur A. Crafts & Co., 125 Summer St., Boston, Mass. Catalogue 22, entitled "Diamonds Used in Tools," treating of the use of diamonds for truing carborundum, alundum, crystolon, and other types of hard grinding wheels. Price lists are given for this company's line of diamond tools, including grinding wheel dressers, lathe turning tools, drills, glass cutters, engine turners' tools, wire drawing dies, etc.

Joseph T. Ryerson & Son, 30 Church St., New York City, has made a change in its bi-monthly "Stock List," having added a magazine feature in the front and a machinery and small tools section in the back of the book, which doubles the number of pages. It is hoped that the magazine section will serve as an exchange for suggestions and ideas, as well as a clearing-house to assist customers in disposing of odd stock and used machinery.

Bastian-Blessing Co., 125 W. Austin Ave., Chicago, Ill., is issuing a monthly publication called "Sparks" which will deal with the subject of welding or cutting by the oxy-acetylene or oxy-hydrogen process. In the first number is described a new "Rego" outfit known as the "Rego Little Six," which is particularly applicable for welding, cutting, brazing and decarbonizing in garages or small repair shops. Copies will be sent to anyone interested in this subject.

Goddard & Goddard Co., Detroit Mich., is issuing a series of pamphlets entitled "Real Production Tools," the first of which gives data on the "Go & Go" half side-mill which is designed to be used in pairs, right and left. No. 2 of the series gives information on the "Go & Go" plain mill. The third pamphlet is on the "Go & Go" inserted-tooth mill which consists of an alloy steel body and high-speed steel blades, and is intended for work requiring cutters 10 inches in diameter or larger.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue containing a detailed description and a large number of illustrations of LeBlond heavy-duty crankshaft lathes for the rapid production of automobile, gas engine, airplane, air compressor and other crankshafts. These machines are built in universal and duplex types for finishing crankpins either singly or in pairs, according to the design of the crankshaft and the requirements of the customer. Complete specifications are included.

Norton Co., Worcester, Mass. Pamphlet entitled "Metal Polishing," containing an article giving considerable information on the polishing of metal, including the correct abrasives to use; methods of setting up grinding wheels; drying wheels; size of grain used for different operations; polishing wheels; balance of wheels, speed, etc. Pamphlet entitled "Factors Affecting Grinding Wheel Selection," containing a definite outline of the conditions governing the correct selection of grinding wheels. Four tables are given listing the factors influencing the selection of the abrasive, grit, grade, and process respectively. A valuable feature of the booklet is the tabular material giving the abrasive process and the correct grade and grain of wheel to be used for different classes of work and operations.

TRADE NOTES

Cutler-Hammer Mfg. Co., Milwaukee, Wis., has moved its Boston office from the Columbian Life Building to Rooms 403 and 404 Harvey Building, Chancy St. C. W. Yerger is manager of this office.

Nickel Engineering Works, Saginaw, Mich., manufacturers of agitator equipment for chemical tanks, have leased a portion of the Schemm Brewing Co.'s plant, 920 N. Hamilton St., for machine shop purposes.

W. S. Rockwell Co., 50 Church St., New York City, furnace engineers and contractors, announce that Gibbons Bros., Ltd., Dudley, Worcester, England, has been appointed representative of the company for the British Isles.

Surface Combustion Co., Inc., 366 Gerard Ave., Bronx, New York City, has been awarded the contract for an automatic heat-treating furnace to be installed at the Naval Ordnance plant in South Charleston, W. Va., for heat-treating 16-inch armor-piercing shells.

American Motors Service has been organized in Pittsburg, Pa., by G. E. Burroughs and I. V. Conneely, for the purpose of distributing motor parts, tools, machines, and appliances for the complete equipment of garages. The temporary address of the concern is Lock Box 447 N.S., Pittsburg.

C. F. Davis Machine Co., Inc., 133 Andrews St., Rochester, N. Y., announces that it is and has been a separate and distinct organization from the Davis Machine Tool Co., also of Rochester. The similarity of names has caused some misunderstanding in the past and the announcement has been made to clear the matter up.

Reed-Prentice Co. and associate companies, the **Becker Milling Machine Co.** and the **Whitcomb-Blaisdell Machine Tool Co.**, have removed their New York office from the Grand Central Palace, 480 Lexington Ave., New York City, to Room 536, Singer Bldg., 149 Broadway, New York. The New York office is under the direction of P. K. Dayton, New York sales manager.

McCabe & Sheeran Machinery Corporation, Singer Bldg., New York City, has been organized by Harry P. McCabe and P. Frank Sheeran to deal in new and used machine tools and to act as manufacturers' direct representatives. Mr. McCabe was associated for twenty-five years with the J. J. McCabe Lathe & Machinery Corporation, the last three of which he was vice-president. Mr. Sheeran was connected with the same concern for twenty-three years, latterly as treasurer and chief of sales and advertising.

Morley Machinery Corporation (successor to the **W. A. Wilson Machine Co.**, and the **Rochester Boiler Works**), manufacturer of iron planers and special machinery, has recently purchased and is now located in the plant formerly occupied by the Defiance Check Writer Corporation at 792-814 St. Paul St., Rochester, N. Y. New equipment has been purchased, and as the new property has a railroad siding the plant now occupied offers excellent manufacturing facilities.

Reading Machinery Exchange, 437 Washington St., Reading, Pa., has changed its firm name to **Reading Machine & Tool Co.** This change has been made because of the fact that the company some time ago discontinued handling used machinery, and since then has been devoting its entire time to the sale of new metal-working and woodworking machinery and tools, electric motors, and industrial furnaces. The new name has therefore been adopted as being more descriptive of the firm's present activities.

Warren F. Fraser Co., Westboro, Mass., manufacturer of cylindrical grinding machinery, plain cylinder grinders, special machine tools, and metal products, has been reorganized. The officers of the reorganized company are as follows: president, Warren F. Fraser; vice-president, Frank H. McClaskey; general manager, Sidney Player; sales manager, Joseph N. Bethel; treasurer, Maurice J. Cashman; assistant treasurer, Richard S. Staples; consulting engineer, Herbert S. Indge; and factory superintendent, Alfred E. Box. Messrs. Player, Bethel, Staples, Indge, and Box have also become stockholders in the company.